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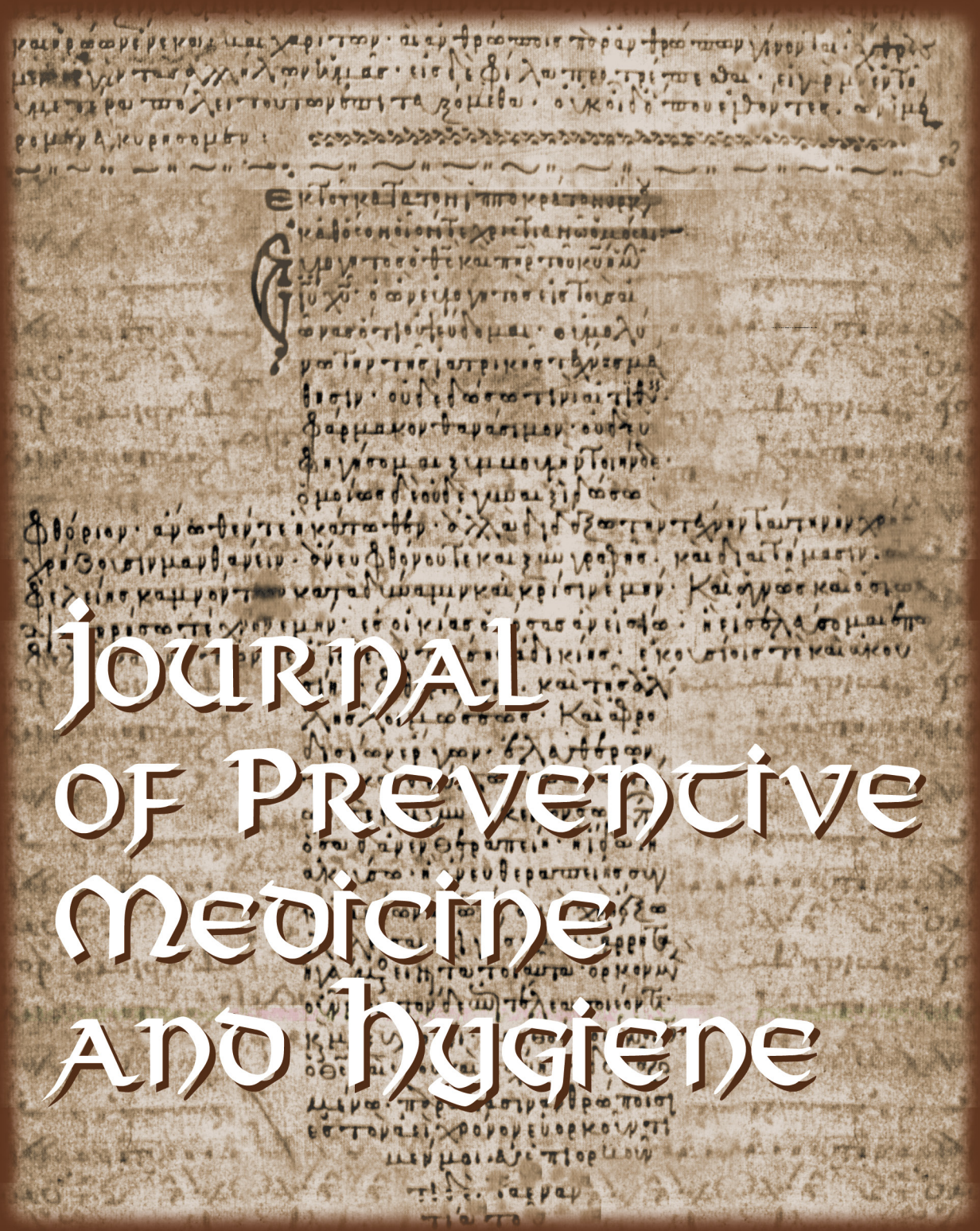

The original document of Hippocrates' oath

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Contents

HEALTH PROMOTION

Maternal methylenetetrahydrofolate reductase (MTHFR) A1298C polymorphism: implications in preventing recurrent pregnancy loss

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Keywords

Early pregnancy loss • MTHFR • Gene mutation • Adverse pregnancy outcomes • Methylenetetrahydrofolate reductase A1298C • Polymorphism • Case study

Dear Editor,

Adverse pregnancy outcomes, such as preeclampsia, gestational hypertension, preterm birth, recurrent pregnancy loss, and ectopic pregnancy, are typically caused by multiple factors and can endanger both maternal and neonatal health. An intricate interplay of factors, including maternal nutrition, age, lifestyle, socioeconomic status, and genetic predisposition from both parents, collectively influences the progression and outcome of a pregnancy [1, 2].

The MTHFR (Methylenetetrahydrofolate Reductase) enzyme plays a pivotal role in maintaining intracellular folate balance, a critical component for various cellular processes. This enzyme facilitates the conversion of 5, 10-methylenetetrahydrofolate into 5, 5-methyltetrahydrofolate, a critical methyl donor essential for methylation reactions. These reactions, in turn, influence DNA synthesis, repair, stability, purine, and pyrimidine nucleoside synthesis, and the generation of S-adenosyl methionine (SAM), another key methyl donor involved in biological processes like protein and nucleic acid methylation [3, 4].

The polymorphism MTHFR A1298C mimics a folate deficit by reducing enzymatic activity. The relationship between the MTHFR A1298C polymorphism and RPL risk has been the subject of several researches to far, however the findings are still debatable and unclear. MTHFR gene polymorphisms are relatively common, with estimated frequencies ranging from 5 to 14 percent in different populations [5].

Folate, a vital nutrient, plays a crucial role in the growth and development of both the placenta and fetus. Insufficient folate intake can lead to hyperhomocysteinemia, which damages the vascular endothelium and contributes to endothelial dysfunction and placental vasculopathy [5, 6]. These obstetric complications and thrombotic events primarily stem from hyperhomocysteinemia and disturbances in the homocysteine-related metabolic pathways [7, 8]. Proper homocysteine metabolism is vital, as elevated homocysteine levels can damage various cellular structures within the placenta, leading to inflammation and impaired fetal perfusion [5, 9, 10].

In this case report, we present the case of a pregnant woman with a history of recurrent early pregnancy loss and ectopic pregnancy. Early detection and management of her condition were critical in ensuring a healthy pregnancy outcome.

A 28-year-old woman from a low socioeconomic status background, presented with a history of four first-trimester miscarriages and a ruptured ectopic pregnancy. She had received genetic testing, which identified the MTHFR A1298C polymorphism. She was provided with genetic counseling and initiated on Planned Parenthood and folic acid supplementation during the preconception period. Her initial laboratory results indicated anemia and thrombocytopenia, categorizing her as a high-risk pregnancy. Subsequently, she was referred to a tertiary medical facility for further evaluation and management.

Given her history of recurrent pregnancy loss, prophylactic anticoagulation with low molecular weight heparin and low-dose aspirin were prescribed in the second trimester. Routine monitoring of her pregnancy, including biophysical profile studies and fetal movement tracking, was initiated to ensure the well-being of the fetus. At 38 full weeks of pregnancy, she gave birth to a healthy daughter who weighed 3.3 kg. The baby was active and crying right away, indicating a good neonatal outcome, and the labor and postpartum time went well.

Discussion

DNA methylation is a crucial aspect of epigenetics that plays a vital role in cellular growth, differentiation, and the development of various human disorders. The MTHFR A1298C gene variation involves a change at position 1298 of the MTFHR gene, where the expected DNA base “A” is replaced by “C.” It’s worth noting that this specific MTHR A1298C variation does not significantly hinder enzymatic activity but resembles a deficiency in folate [11]. The link between the MTHFR A1298C polymorphism and the risk of recurrent miscarriage has been the subject of numerous studies, although the results

remain contentious and unclear [10, 12]. In contrast to Rai's findings in a meta-analysis that suggested no association between the A1298C polymorphism and recurrent pregnancy loss, Yang et al. reported that both maternal and paternal MTHFR gene C677T and A1298C polymorphisms are associated with recurrent adverse obstetrical outcomes [13, 14]. To reconcile these contradictory results, further research with larger, well-designed studies, addressing potential sources of heterogeneity, and considering gene-environment interactions, would be necessary. It's also important for the scientific community to engage in ongoing dialogue and conduct additional systematic reviews and meta-analyses to refine our understanding of the relationship between MTHFR gene polymorphisms and recurrent pregnancy loss.

It is well-established that MTHFR polymorphism leads to elevated levels of total homocysteine. Lowering total homocysteine levels is associated with engaging in regular physical activity and ensuring sufficient intake of folate and vitamin B-12. Consequently, individuals with MTHFR 1298 CC and 1298 AC genotypes can benefit from maintaining a balanced diet rich in folic acid and vitamin B-12, complemented by appropriate physical exercise [15, 16].

Research has indicated that the incidence of unexplained pregnancy losses can be reduced when hyperhomocysteinemia levels in the blood are lowered through oral folate supplementation [17]. However, there is no universally accepted recommendation regarding folic acid supplementation for populations with varying MTHFR genotypes. Therefore, further investigation is needed in this area.

At the primary healthcare level, identifying and registering pregnancies early, along with investigating adverse pregnancy outcomes, can help prevent recurrent pregnancy loss associated with MTFHR gene mutations. In the case presented here, early registration of the pregnancy and prompt reporting and investigation of repeated abortions could have potentially mitigated the unfavorable outcomes. Both the mother and the fetus could have benefited from appropriate treatments, including preconception folic acid supplements and nutritional guidance. It is imperative that healthcare workers in the community recognize the importance of early registration and reporting adverse pregnancy outcomes. Responsible authorities should conduct thorough investigations in the aftermath of such negative events, followed by swift implementation of effective measures, especially in resource-constrained settings.

This case underscores the importance of early detection of the MTHFR A1298C polymorphism in pregnant women with a history of recurrent pregnancy loss. Implementing proper folic acid supplementation and genetic counseling can significantly improve pregnancy outcomes. Healthcare providers at the community level must emphasize early registration of pregnancies and prompt investigation of adverse outcomes to provide timely interventions, particularly in resource-limited settings.

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None.

Conflict of interest statement

None.

References

[1] Roberts CT. IFPA Award in Placentology Lecture: complicated interactions between genes and the environment in placentation, pregnancy outcome and long term health. Placenta 2010;31(Suppl):S47-53. https://doi.org/10.1016/j.placenta.2010.01.001.

[2] Jankovic-Karasoulos T, Furness DL, Leemaqz SY, Dekker GA, Grzeskowiak LE, Grieger JA, Andraweera PH, McCullough D, McAninch D, McCowan LM, Bianco-Miotto T, Roberts CT. Maternal folate, one-carbon metabolism and pregnancy outcomes. Matern Child Nutr 2021;17:e13064. https://doi.org/10.1111/mcn.13064.

[3] Liew SC, Gupta ED. Methylenetetrahydrofolate reductase (MTHFR) C677T polymorphism: epidemiology, metabolism and the associated diseases. Eur J Med Genet 2015;58:1-10. https://doi.org/10.1016/j.ejmg.2014.10.004.

[4] Castiglia P, Sanna V, Azara A, De Miglio MR, Murgia L, Pira G, Sanges F, Fancellu A, Carru C, Bisail M, Muroni MR. Methylenetetrahydrofolate reductase (MTHFR) C677T and A1298C polymorphisms in breast cancer: a Sardinian preliminary case-control study. Int J Med Sci 2019;16:1089-95. https://doi.org/10.7150/ijms.32162.

[5] Turgal M, Gumruk F, Karaagaoglu E, Beksac MS. Methylenetetrahydrofolate reductase polymorphisms and pregnancy outcome. Geburtshilfe Frauenheilkd 2018;78:871-8. https://doi.org/10.1055/a-0664-8237.

[6] Greenberg JA, Bell SJ, Guan Y, Yu YH. Folic acid supplementation and pregnancy: more than just neural tube defect prevention. Rev Obstet Gynecol 2011;4:52-9.

[7] Tsitsiou E, Sibley CP, D'Souza SW, Catanescu O, Jacobsen DW, Glazier JD. Homocysteine transport by systems L, A and y+L across the microvillous plasma membrane of human placenta. J Physiol 2009;587:4001-13. https://doi.org/10.1113/jphysiol.2009.173393.

[8]. Jansson T. Novel mechanism causing restricted fetal growth: does maternal homocysteine impair placental amino acid transport? J Physiol 2009;587:4123. https://doi.org/10.1113/jphysiol.2009.178327.

[9] Kamudhamas A, Pang L, Smith SD, Sadovsky Y, Nelson DM. Homocysteine thiolactone induces apoptosis in cultured human trophoblasts: a mechanism for homocysteine-mediated placental dysfunction? Am J Obstet Gynecol 2004;191:563-71. https://doi.org/10.1016/j.ajog.2004.01.037.

[10] Alfirevic Z, Roberts D, Martlew V. How strong is the association between maternal thrombophilia and adverse pregnancy outcome? A systematic review. Eur J Obste tGynecol Reprod Biol 2002;101:6-14. https://doi.org/10.1016/s0301-2115(01)00496-1.

[11] Centers for Disease Control and Prevention. MTHFR gene, folic acid, and preventing neural tube defects [Online]. 2002 Jun 15. Available at: https://www.cdc.gov/ncbddd/folicacid/mthfr-gene-and-folic-acid.html (Accessed on: 24/06/2023).

[12] Foka ZJ, Lambropoulos AF, Saravelos H, Karas GB, Karavida A, Agorastos T, Zournatzi V, Makris PE, Bontis J, Kotsis A. Factor V leiden and prothrombin G20210A mutations, but not methylenetetrahydrofolate reductase C677T, are associated

with recurrent miscarriages. Human Reprod (Oxford, England) 2000;15(2):458–462. https://doi.org/10.1093/humrep/15.2.458.

[13] Rai V. Methylenetetrahydrofolate reductase gene A1298C polymorphism and susceptibility to recurrent pregnancy loss: a meta-analysis. Cell Mol Biol (Noisy-le-grand) 2014;60:27-34.

[14] Yang Y, Luo Y, Yuan J, Tang Y, Xiong L, Xu M, Rao X, Liu H. Association between maternal, fetal and paternal MTHFR gene C677T and A1298C polymorphisms and risk of recurrent pregnancy loss: a comprehensive evaluation. Arch Gynecol Obstet 2016;293:1197-211. https://doi.org/10.1007/s00404-015-3944-2.

[15] Nair RR, Khanna A, Singh R, Singh K. Association of maternal and fetal MTHFR A1298C polymorphism with the risk of pregnancy loss: a study of an Indian population and a meta-analysis. Fertil Steril 2013;99:1311-1318.e4. https://doi.org/10.1016/j.fertnstert.2012.12.027.

[16] Kumar J, Das SK, Sharma P, Karthikeyan G, Ramakrishnan L, Sengupta S. Homocysteine levels are associated with MTHFR A1298C polymorphism in Indian population. J Hum Genet 2005;50:655-63. https://doi.org/10.1007/s10038-005-0313-1.

[17] Gaskins AJ, Rich-Edwards JW, Hauser R, Williams PL, Gillman MW, Ginsburg ES, Missmer SA, Chavarro JE. Maternal prepregnancy folate intake and risk of spontaneous abortion and stillbirth. Obstet Gynecol 2014;124:23-31. https://doi.org/10.1097/AOG.0000000000000343.

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COVID-19

Adding COVID to cancer: does cancer status influence COVID-19 infection preventive behaviors?

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Keywords

COVID-19 • Preventive behaviors • Cancer survivors • Health belief model

Summary

Introduction. *A better understanding of how to promote disease mitigation and prevention behaviors among vulnerable populations, such as cancer survivors, is needed. This study aimed to determine patterns of and factors associated with COVID-19-related preventive behaviors among cancer survivors and assess whether the COVID-19 preventive behaviors of cancer survivors differ from the general population.*
Methods. *In June 2020, an online survey of adults (N = 897) assessed predictors of COVID-19-related preventive behaviors, including socio-demographics, COVID-19 beliefs and perceptions (Health Belief Model [HBM] variables), and cancer statuses (cancer survivors currently in treatment, cancer survivors not currently in treatment, and individuals with no history of cancer). An average score of respondent engagement in eight preventive behaviors was calculated. Differences in HBM variables and preventive behaviors by cancer status were assessed using ANCOVAs. Hierarchical multiple regression analyzed associations among socio-demographics, HBM constructs, cancer statuses, and engagement in COVID-19 preventive behaviors.*
Results. *Participants reported engaging in 3.5 (SD = 0.6) preventive behaviors. Cancer survivors not in treatment engaged in preventive behaviors significantly less than the comparison group. In the final adjusted model, after adding COVID-19 beliefs and perceptions, cancer status was no longer significant. All HBM constructs except perceived susceptibility were significant predictors of preventive behaviors.*
Conclusions. *COVID-19 beliefs and perceptions were more robust predictors preventive behaviors than cancer status. Nonetheless, public health organizations and practitioners should communicate the risk and severity of infection among cancer survivors and emphasize the need to engage in protective behaviors for COVID-19 and other infectious diseases with this vulnerable population.*

Introduction

Individuals who are immunosuppressed, such as people undergoing certain cancer treatments, are at increased risk of COVID-19-related morbidity and mortality [1, 2]. A better understanding of how to promote mitigation and prevention behaviors among vulnerable populations is needed in general as well as in the case of future infectious disease outbreaks.
An early study from China showed cancer patients, specifically, may have a higher risk of COVID-19 infection than individuals without cancer and that cancer patients had poorer COVID-19 outcomes, such as requiring ventilation and death [3]. Additionally, the pandemic has likely caused a host of negative outcomes for cancer survivors, including disruptions in their treatment and survivorship care. A systematic review of the cancer survivor literature published shortly after data in the present study were collected suggested the pandemic has introduced new challenges related to social isolation, financial hardship, and uncertainty with respect to ongoing care [4]. These consequences of COVID-19 for cancer survivors may disproportionately affect survivors in active treatment [5, 6], including those who are immunosuppressed by the disease itself or treatment. However, research suggests both those receiving chemotherapy and those who have completed treatment may be at increased risk of developing severe symptoms [7]. Since COVID-19 is highly contagious and potentially fatal, measures such as stay-at-home orders and social distancing were implemented worldwide to slow the spread of the virus. In addition, infection preventive behaviors such as washing hands, staying home when sick, and wearing a face mask were recommended to reduce the risk of contracting and spreading the virus, even after being fully vaccinated against COVID-19 [8]. Uptake of preventive behaviors among those at greater risk for adverse outcomes of COVID-19 infection is especially important for personal protection.
Although the body of literature is growing, there is limited research examining the practice of COVID-19 infection preventive behaviors in cancer patients [9-10]. Analyses of a nationally representative sample suggest that cancer survivors and immunocompromised adults are more likely to practice preventive behaviors than those with no history of cancer [10, 11]. However, these studies did not differentiate by cancer survivor treatment status. In addition, prior research suggests differences in

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the endorsement of COVID-19 misinformation beliefs based on cancer status, with survivors currently receiving treatment being more likely to endorse false statements about the pandemic, compared to those without a cancer history [12]. Studies have also found a relationship between misinformation beliefs and lower performance of COVID-19-related preventive behaviors [13-14]. Although it is unclear why individuals with cancer are more vulnerable to misinformation, it may undermine how well cancer patients adhere to the guidelines for behaviors to prevent COVID-19. It is crucial to understand why some individuals follow recommendations strictly and others do not, especially cancer patients who are at increased risk for negative disease sequalae.

The Health Belief Model (HBM) is a well-known health behavior theory that is often associated with engaging in preventive behaviors [15-18]. The HBM proposes that intention to perform the preventive behavior is dependent on (a) the level of perceived threat (consisting of *perceived severity* – how serious someone perceives COVID-19 to be – and *perceived susceptibility* – how likely someone believes they are to contract COVID-19), (b) *perceived benefits* of the preventive behavior (whether someone believes the behavior will protect them from getting COVID-19) (c) *perceived barriers* to the preventive behavior (*e.g.*, is uncomfortable wearing a mask), and (d) *self-efficacy* for performing the preventive behavior. The present study examined whether the HBM constructs are associated with engagement in preventive behaviors during the COVID-19 infection. Understanding how the HBM predicts engagement can inform future efforts to increase engagement in preventive behaviors now and in future infectious disease outbreaks.

In light of the serious potential impact of COVID-19 on cancer patients, further examination of the uptake of preventive behaviors in this population relative to other groups is warranted. The purpose of this study, therefore, was to assess differences in engagement in COVID-19 infection preventive behaviors during the COVID-19 pandemic (Aim 1a) and HBM constructs (Aim 1b) among the three groups of adults (cancer survivors in active treatment, cancer survivors not receiving treatment currently, and a comparison group without a history of cancer). The second aim of this research aim was to determine which individual characteristics and other factors (HBM constructs and history of cancer) are associated with performance of preventive behaviors during the pandemic. Finally, the HBM constructs were assessed as predictors of COVID-19 preventive behaviors within each cancer survivor group separately (Aim 3). We hypothesized that cancer survivors in active treatment would be the most engaged in COVID-19 preventive behaviors due to their increased potential to be immunocompromised.

Methods

Survey administration and sample

United States (U.S.) residents (N = 897) were recruited through a commercial survey administration and sampling company, Qualtrics, in June 2020. Quota sampling was utilized to ensure the sample would consist of approximately one-third of cancer survivors currently in treatment, one-third of cancer survivors not currently in treatment, and one-third of individuals without a history of cancer. Another quota was implemented to assure an approximately equal proportion of female and male respondents. Survey items collected information on socio-demographic characteristics, Health Belief Model components, and COVID-19-related preventive behaviors. These preventive behaviors were among the most important COVID-19 prevention strategies at the time these data were collected as no vaccines were available yet. Moreover, these behaviors (*e.g.*, frequent handwashing and mask wearing) are routinely recommended to vulnerable groups, such as cancer survivors. Data collection was anonymized. The study was approved by the Institutional Review Board of a large mid-Atlantic university.

Measures

Cancer status

Participants were assigned a label according to their self-reported cancer status. The three cancer status groups were delineated as cancer survivors in active treatment, cancer survivors not receiving treatment currently, and respondents with no history of cancer (comparison group).

Socio-demographic characteristics

(age, sex, race/ethnicity, educational attainment, and marital status). Respondent age in years and sex (female or male) were queried. Race/ethnicity was assessed with three mutually exclusive options (White/Caucasian, Black/African American, and Hispanic). Participants were asked to indicate their highest education level attained. This variable was collapsed to indicate college-educated versus other. Finally, marital status was assessed and collapsed to married/living together or other.

Health belief model constructs

Participants rated their agreement with statements related to their perceived susceptibility, severity, benefits, and barriers on a seven-point Likert scale ranging from "strongly disagree" to "strongly agree". ***Perceived severity*** of COVID-19 was determined using three items from a study focused on a pandemic flu vaccine by [15] (*e.g.*, "Complications of COVID-19 are serious"). Cronbach's alpha was.834. The mean of the three items was calculated as an overall measure of perceived severity. ***Perceived susceptibility*** to COVID-19 was measured using three items (*e.g.*, "I am worried about the likelihood of getting COVID-19 in the near future") [15]. Cronbach's alpha was.801. The mean of the three items was calculated as an overall measure of perceived susceptibility. ***Perceived benefits*** of COVID-19 preventive behaviors were measured using eight items focused on the benefits of COVID-19

Tab. I. Sample Characteristics (N = 897).

	Cancer Survivors		Comparison
	In active treatment. *(n = 287)*	Not in active treatment. *(n = 301)*	No history of cancer. *(n = 309)*
Characteristic	**% (n)**	**% (n)**	**% (n)**
Education			
College degree or higher	55.7% (*n* = 160)	48.8% (n = 147)	42.7% (n = 132)
Other	44.3% (*n* = 127)	51.2% (n = 154)	57.3% (n = 177)
Gender			
Male. Female	47.0% (*n* = 135). 53.0% (*n* = 152)	48.2% (n = 145) 51.8% (n = 156)	49.8% (n = 154) 50.2% (n = 155)
Race			
White/Caucasian	80.1% (*n* = 230)	87.4% (n = 263)	34.0% (n = 105)
Black/African American	9.8% (n = 28)	7.6% (n = 23)	32.4% (n = 100)
Hispanic	10.1% (n = 29)	5.0% (n = 15)	33.7% (n = 104)
Marital Status			
Married or living together	70.4% (*n* = 202)	62.8% (n = 189)	53.1% (n = 164)
Other	29.6% (*n* = 85)	37.2% (n = 112)	46.9% (n = 145)
	M, SD	***M, SD***	
Age (years)	48.2, 17.1	56.4, 16.2	44.3, 16.3
Preventive Behaviors	3.5, 0.6	3.4, 0.6	3.6, 0.5

preventive behaviors (*e.g.*, "Wearing a mask in public can help prevent contracting and spreading COVID-19") [15, 18]. Cronbach's alpha was. 920, and the mean of the four items was calculated as an overall measure of perceived benefits. ***Perceived barriers*** to COVID-19 preventive behaviors were measured using eight items asking respondents to rate how difficult it would be for them to perform specific preventive behaviors [15, 18]. Cronbach's alpha was.846, and the mean of the ten items was calculated as an overall measure of perceived barriers. ***Self-efficacy*** was measured by three items (*e.g.*, "How certain are you that you can perform COVID-19 preventive behaviors?" [15] and assessed using a six-point Likert scale ranging from "very difficult" to "very easy." Cronbach's alpha was .878. The mean of the three items was calculated as an overall measure of self-efficacy.

COVID-19-related preventive behaviors

Behaviors including handwashing, avoiding contact with sick people, staying home when feeling sick, respiratory hygiene, avoiding touching face, social distancing, avoiding large gatherings, and wearing a mask were assessed. Engagement in these eight behaviors during the past week was reported on a 4-point Likert scale ranging from never to frequently. The Cronbach's alpha for these behaviors was high (.908) and thus, an average score of all behaviors was computed for each participant, with higher scores indicating higher overall engagement in COVID-19 preventive behaviors.

Statistical analyses

Differences among cancer status groups in HBM constructs and COVID-19-related preventive behaviors, controlling for socio-demographic characteristics, were assessed using analysis of covariance (ANCOVA) tests. Hierarchical multiple regression analysis was used to determine how socio-demographic characteristics, HBM constructs, and cancer status were associated with engagement in preventive COVID-19 behaviors. Socio-demographic covariates included age, gender, race, education, and marital status. Since the comparison group has no history of cancer, it was not possible to include cancer type as a covariate in the analyses. The effects of the independent variables were expressed in terms of standardized regression coefficients (betas). The amount of variance explained in the models was reported in terms of R^2. The threshold for statistical significance used in this study was p-value <.05. SPSS 27.0 was used for all analyses.

Results

Sample characteristics

Respondents were 49.61 years (SD = 17.27) on average, 51.6% female, and 48.9% had a Bachelor's degree or higher educational attainment. Most respondents were White (66.7%), followed by 16.8% Black and 16.5% Hispanic. More than one-half of respondents were married or living with a partner (61.9%). The average score for preventive behaviors was 3.49 (SD = 0.56). Among the cancer survivors, diagnoses included solid tissue (81.3%), blood (9.9%), and skin (8.8%) cancers. Sample characteristics by cancer status group are shown in Table I.

COVID-19 preventive behaviors by cancer status

There was a significant effect of cancer status on COVID-19 infection preventive behaviors for the three groups [$F(2,889) = 4.695$, p =.009, partial eta^2 =.010]. Bonferroni-corrected post-hoc comparisons indicated

the mean score for preventive behaviors among cancer survivors not in treatment (M = 3.414, SE = .603) was significantly lower than the comparison group of respondents with no history of cancer (M = 3.558, SE = .516), p = .008. There was no significant difference between cancer survivors in treatment (M = 3.500, SE = .565) and either survivors not in treatment or the comparison group.

HBM constructs by cancer status

There was a significant effect of cancer status on ***perceived susceptibility*** across the three groups [F(2,889) = 7.300, p = .001, partial eta^2 = .016]. Bonferroni-corrected post-hoc comparisons indicated that the mean of the comparison group (M = 2.46, SE = .073) was significantly lower than both cancer survivors in active treatment (M = 2.85, SE = .070), p = .001 and those not in treatment (M = 2.75, SE = .071), p = .02. There was also a significant effect of cancer status on ***perceived severity*** across the three groups [F(2,889) = 4.959, p = .007, partial eta^2 = .011]. Bonferroni- corrected post-hoc comparisons indicated that the mean of the comparison group (M = 4.70, SE = .047) was significantly higher than both cancer survivors in active treatment (M = 4.52, SE = .045), p = .026, and those not in treatment (M = 4.49, SE = .046), p = .011. There was a significant effect of cancer status on ***perceived benefits*** for the three groups [F(2,889) = 8.482, p <.001, partial eta^2 = .019]. Bonferroni-corrected post-hoc comparisons indicated the comparison group (M = 4.74, SE = .038) was significantly higher than both cancer survivors in active treatment (M = 4.53, SE = .036), p <.001, and those not in treatment (M = 4.56, SE = .037), p = .004. Lastly, the effects of cancer status on ***perceived barriers*** F(2,889) = 0.343, p = .710, partial eta^2 = .001] and ***self-efficacy*** [F(2,889) = 2.780, p = .063, partial eta^2 = .006] for the three groups were not significant.

Overall Predictors of COVID-19 Preventive Behaviors.

Almost all socio-demographic characteristics (age, race/ethnicity, gender, and marital status [all p-values <.05]) were significant in the first model examining socio-demographics as predictors of preventive behavior. The R^2 of this model was. 038, with demographics explaining 3.8% of the variance, F(6,890) = 6.948, p <.001. When cancer status was added in model 2, most of the socio-demographic characteristics remained significant and cancer survivors not in treatment currently reported significantly lower preventive behaviors compared to the comparison group with no history of cancer (p = .003). In model 2, the R^2 was.046, meaning with the addition of cancer status, the model explained 4.6% of the variance in the model, F(8,888) = 6.426, p < .001. In model 3, when HBM constructs were added along with the other covariates, cancer status was no longer significant but all HBM constructs except perceived susceptibility were significant. Specifically, those with greater perceived severity, benefits, and self-efficacy reported significantly higher engagement in COVID-19 preventive behaviors (all p-values < .01). Those with greater perceived barriers reported significantly lower preventive behaviors (p = .002). When the HBM variables were added to the model, the R^2 increased to.480, F(13,883) = 64.563, p < .001. This indicates that the HBM constructs accounted for an additional 43.4% of the variance. Complete results for each model predicting preventive behaviors are shown in Table II.

To determine whether the effects of the HBM constructs on preventive behaviors differed as a function of survivor group, we ran post hoc pairwise comparisons where interaction terms were created between each survivor group and HBM constructs. No significant interactions were found (all ps >.05) and there were no cases in which the two groups had an absolute value magnitude difference of.10 or larger in their beta weight for a specific HBM construct.

Tab. II. Results of Hierarchical Multiple Regression Predicting Preventive Behaviors.

Variable	Beta	p-value	Beta	p-value	Beta	p-value
Socio-demographics						
Age	**.083**	**.016***	**.109**	**.002***	**-.081**	**.003***
Black (Ref: White)	**.126**	**<.001***	**.089**	**.017***	.046	.098
Hispanic (Ref: White)	**.076**	**.031***	.039	.301	.029	.296
Female (Ref: Male)	**.157**	**<.001***	**.159**	**<.001***	**.056**	**.029***
College degree (Ref: Other)	.059	.093	.061	.083	.012	.629
Married[1] (Ref: Other)	**.116**	**<.001***	**.116**	**<.001***	.049	.054
Cancer status						
Cancer status: In treatment (Ref: Comparison)			-.053	.198	.028	.362
Cancer status: Not in treatment (Ref: Comparison)			**-.131**	**.003***	-.058	.077
HBM constructs						
Perceived Susceptibility					.017	.485
Perceived Severity					**.086**	**.005***
Perceived Benefits					**.369**	**<.001***
Perceived Barriers					**-.116**	**.002***
Perceived Self-efficacy					**.227**	**<.001***

[1] Includes married respondents as well as those living with a significant other.

Discussion

The purpose of this study was to assess differences in engagement in COVID-19 infection preventive behaviors during the pandemic between two cancer survivor groups (survivors in active treatment and those not currently receiving treatment) and a comparison group (adults with no history of cancer). Our hypothesis was not supported; there was no significant difference in engagement in preventive behaviors between cancer survivors in treatment and either survivors not in treatment or the comparison group while controlling for socio-demographics. However, cancer survivors not in treatment engaged in fewer preventive behaviors compared to the comparison group. We also analyzed results through the lens of the HBM, a health behavior theory often used in studies of preventive behaviors. In adjusted models controlling for socio-demographic, all HBM variables except perceived susceptibility were significant predictors of preventive behaviors, while the influence of cancer status was no longer significant.

Our comparison of COVID-19 beliefs and perceptions (HBM variables) by cancer status yielded interesting results. Both cancer survivor groups reported higher susceptibility to COVID-19 than the comparison group, which may accurately reflect their elevated level of infection risk [19]. However, cancer survivors also reported lower perceived severity of COVID-19 as compared to those without a history of cancer. One potential explanation for this finding may be that survivors have a diminished perception of the severity of COVID-19 because they have experienced much greater health challenges relative to others with no history of cancer, including their cancer symptoms and treatment side effects. Nonetheless, people with a cancer history remain at an increased risk of serious complications from COVID-19 [19-21]; so this perception is concerning. Future research should attempt to understand the cognitive mechanisms underlying these differences. Another potentially troublesome finding is how perceived benefits of preventive behaviors were lower among cancer survivors, as many of the behaviors assessed are the same as those routinely recommended for infection prevention for immunosuppressed cancer survivors. Those with lowered immune systems, a potential side effect of cancer treatment, should be engaging in preventive behaviors the most. While a mild case of COVID-19 may be not be as serious as cancer, severe cases of COVID-19 – especially among those with a history of cancer – can have equally grave consequences. To address this in messages targeting cancer survivors, public health and communication professionals should emphasize the benefits of COVID-19 infection preventive behaviors and the severity of COVID-19.

Results of the adjusted models predicting COVID-19 preventive behaviors suggest that COVID-19 beliefs and perceptions (HBM variables) have a greater impact on performance of preventive behaviors during a pandemic than cancer status [22]. Therefore, public health communication efforts should focus on HBM constructs when promoting COVID-19 preventive behaviors.

Finally, it should be noted that when the HBM constructs were added to the final regression model, they explained an additional 43.4% of the variance in COVID-19 preventive behaviors. This provides strong evidence for using the HBM and its constructs as a guiding framework when designing messages to promote infection prevention adherence. This finding is consistent with other studies [22-24]. Therefore, the HBM is relevant for public health and health communication practitioners and will likely remain relevant beyond the COVID-19 pandemic, into future flu seasons and other infectious disease outbreaks.

Strengths, limitations, and future directions

Utilizing a panel sample for this research made it possible to access this unique sample in the time-sensitive period before vaccines were available, when preventive behaviors were the first line of defense against COVID-19 infection. Although use of a panel sample may limit the generalizability of the results, it should not impact the associations examined. Future studies should replicate this research using a random, more representative sample and consider including COVID-19 vaccination as a preventive behavior since a vaccine was not available at the time these data were collected. Detailed medical and treatment information (*e.g.*, stage of cancer diagnosis, time since diagnosis and treatment) was not collected from cancer survivors and could have enhanced our results better in the survivorship context. In addition, interactions with healthcare providers, such as receipt of provider recommendations for COVID-19 infection preventive behaviors, were not collected in this study. Future studies examining preventive behaviors should aim to collect this information when possible as provider recommendations are frequently and highly associated preventive behaviors attitudes and uptake [20, 25]. The impact of this potential confound in the present study is unknown. The study is also limited by it's use of a cross-section survey. A longitudinal survey would have allowed for the assessment of changes in preventive behaviors at different times throughout the course of the pandemic. Finally, data collection was limited to U.S. residents – future studies should include other nationalities and geographic areas, since preventive approaches to COVID-19 as well as cultural factors likely affect both perceptions and behaviors. However, the limitations of this study are balanced by important strengths. One of the primary strengths of this study is its inclusion of cancer survivors with two cancer treatment statuses – survivors currently undergoing treatment and those no longer in treatment. This unique distinction adds to the limited cancer research examining differences between cancer survivor subtypes. In addition, a well-known and commonly accepted health behavior theory, the HBM, was used as a framework for understanding adherence to recommendations for COVID-19 preventive behaviors. Our findings related to the HBM afford insights related to the reasons underlying uptake of COVID-19

preventive behaviors. Future qualitative research would help provide a further nuanced understanding of why individuals do or not do engage in the recommended behaviors.

Conclusions

This study focused on identifying differences in COVID-19 infection preventive behaviors and HBM constructs among three unique groups (cancer survivors in active treatment, cancer survivors not receiving treatment currently, and a comparison group without a history of cancer). In addition, we assessed which factors predicted COVID-19 predictive behaviors during the pandemic. Collectively, our findings suggest that COVID-19-related beliefs and perceptions (HBM constructs) matter more than cancer status in predicting adherence to recommended preventive behaviors. Although vaccines against COVID-19 are now widely available, preventive behaviors continue to be recommended to protect vulnerable groups, including cancer survivors. Therefore, public health organizations and practitioners should focus on emphasizing elements of the HBM such as the benefits of preventive behaviors and the potential seriousness of COVID-19 and other infectious diseases.

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Conflict of interest statement

The authors declare that they have no conflicts of interest.

Authors' contributions

CAM, JPDG, BFF: researched literature and conceived the study. CAM, JPDG: designed the survey and gained ethical approval. CAM, JPDG, PBP: conducted data analysis. CAM: wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

References

[1] D'Antiga L. Coronaviruses and immunosuppressed patients: the facts during the third epidemic. Liver Transpl 2020;26:832-4. https://doi.org/10.1002/lt.25756.

[2] Fung M, Babik JM. COVID-19 in immunocompromised hosts: what we know so far. Clin Infect Dis 2021;72:340-50. https://doi.org/10.1093/cid/ciaa863.

[3] Liang W, Guan W, Chen R, Wang W, Li J, Xu K, Li C, Ai Q, Lu W, Liang H, Li S, He J. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. Lancet Oncol 2020;21:335-7. https://doi.org/10.1016/S1470-2045(20)30096-6.

[4] Jammu AS, Chasen MR, Lofters AK, Bhargava R. Systematic rapid living review of the impact of the COVID-19 pandemic on cancer survivors: update to August 27, 2020. Support Care Cancer 2021;29:2841-50. https://doi.org/10.1007/s00520-020-05908-w.

[5] Nekhlyudov L, Duijts S, Hudson SV, Jones JM, Keogh J, Love B, Lustberg M, Smith KC, Tevaarwerk A, Yu X, Feuerstein M. Addressing the needs of cancer survivors during the COVID-19 pandemic. J Cancer Surviv 2020;14:601-6. https://doi.org/10.1007/s11764-020-00884-w.

[6] Al-Quteimat OM, Amer AM. The Impact of the COVID-19 Pandemic on Cancer Patients. Am J Clin Oncol 2020;43:452-5. https://doi.org/10.1097/COC.0000000000000712.

[7] Sun L, Surya S, Le AN, Desai H, Doucette A, Gabriel P, Ritchie MD, Rader D, Maillard I, Bange E, Huang AC, Vonderheide RH, DeMichele A, Verma A, Mamtani R, Maxwell KN. Rates of COVID-19-related outcomes in cancer compared with non-cancer patients. JNCI Cancer Spectr 2021;5:Pkaa120. https://doi.org/10.1093/jncics/pkaa120.

[8] Centers for Disease Control and Prevention. When You've Been Fully Vaccinated. 2021. Available at: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated.html (Accessed on: 03/24/2022).

[9] Shankar A, Saini D, Roy S, Mosavi Jarrahi A, Chakraborty A, Bharti SJ, Taghizadeh-Hesary F. Cancer Care Delivery Challenges Amidst Coronavirus Disease - 19 (COVID-19) outbreak: specific precautions for cancer patients and cancer care providers to prevent spread. Asian Pac J Cancer Prev 2020;21:569-73. https://doi.org/10.31557/APJCP.2020.21.3.569.

[10] Islam JY, Camacho-Rivera M, Vidot DC. Examining COVID-19 preventive behaviors among cancer survivors in the United States: an analysis of the COVID-19 impact survey. Cancer Epidemiol Biomarkers Prev 2020;29:2583-90. https://doi.org/10.1158/1055-9965.EPI-20-0801.

[11] Islam JY, Vidot DC, Havanur A, Camacho-Rivera M. Preventive behaviors and mental health-related symptoms among immunocompromised adults during the COVID-19 pandemic: an analysis of the COVID impact survey. AIDS Res Hum Retroviruses 2021;37:304-13. https://doi.org/10.1089/AID.2020.0302.

[12] Guidry JPD, Miller CA, Ksinan AJ, Rohan JM, Winter MA, Carlyle KE, Fuemmeler BF. COVID-19-related misinformation among parents of patients with pediatric cancer. Emerg Infect Dis 2021;27:650-2. https://doi.org/10.3201/eid2702.203285 .

[13] Burke PF, Masters D, Massey G. Enablers and barriers to COVID-19 vaccine uptake: an international study of perceptions and intentions. Vaccine 2021;39:5116-28. https://doi.org/10.1016/j.vaccine.2021.07.056.

[14] Lee JJ, Kang KA, Wang MP, Zhao SZ, Wong JYH, O'Connor S, Yang SC, Shin S. Associations between COVID-19 misinformation exposure and belief with COVID-19 knowledge and preventive behaviors: cross-sectional online study. J Med Internet Res 2020;22:e22205. https://doi.org/10.2196/22205.

[15] Myers LB, Goodwin R. Using a theoretical framework to determine adults' intention to vaccinate against pandemic swine flu in priority groups in the UK. Public Health 2012;126(Suppl 1):S53-6. https://doi.org/10.1016/j.puhe.2012.05.024.

[16] Rosenstock IM. The health belief model and preventive health behavior. Health Education Monographs 1974;2:354-86. https://doi.org/10.1177/109019817400200405.

[17] Rosenstock IM. Historical origins of the health belief model. Health Education Monographs 1974;2:328-35. https://doi.org/10.1177/109019817400200403.

[18] Coe AB, Gatewood SB, Moczygemba LR, Goode JV, Beckner JO. The use of the health belief model to assess predictors of intent to receive the novel (2009) H1N1 influenza vaccine. Innov Pharm 2012;3:1-11. https://doi.org/10.24926/iip.v3i2.257 .

[19] Gao Y, Liu M, Shi S, Chen Y, Sun Y, Chen J, Tian J. Cancer is associated with the severity and mortality of patients with COVID-19: a systematic review and meta-analysis. MedRxiv 2020.05.01.20087031. https://doi.org/10.1101/2020.05.01.20087031.

[20] Kreuter MW, Chheda SG, Bull FC. How does physician advice influence patient behavior? Evidence for a priming effect. Arch Fam Med 2000;9:426-33. https://doi.org/10.1001/archfami.9.5.426.

[21] Park JM, Koo HY, Lee JR, Lee H, Lee JY. COVID-19 mortality and severity in cancer patients and cancer survivors. J Korean Med Sci 2024;39:e6. https://doi.org/10.3346/jkms.2024.39.e6.

[22] Guidry JPD, Miller CA, Perrin PB, Carlyle KE, Savage MW, Sheppard VB, Fuemmeler BF. Pandemic coping and COVID-19 preventive behaviors among cancer survivors. Patient Educ Couns 2023;112:107716. https://doi.org/10.1016/j.pec.2023.107716.

[23] Barakat AM, Kasemy ZA. Preventive health behaviours during coronavirus disease 2019 pandemic based on health belief model among Egyptians. Middle East Curr Psychiatry 2020;27:43. https://doi.org/10.1186/s43045-020-00051-y.

[24] Fathian-Dastgerdi Z, Khoshgoftar M, Tavakoli B, Jaleh M. Factors associated with preventive behaviors of COVID-19 among adolescents: Applying the health belief model. Res Social Adm Pharm 2021;17:1786-90. https://doi.org/10.1016/j.sapharm.2021.01.014.

[25] Peterson EB, Ostroff JS, DuHamel KN, D'Agostino TA, Hernandez M, Canzona MR, Bylund CL. Impact of provider-patient communication on cancer screening adherence: A systematic review. Prev Med 2016;93:96-105. https://doi.org/10.1016/j.ypmed.2016.09.034.

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COVID-19

SARS-CoV-2 and influenza virus coinfections in the Tuscan population during the 2021/2022 influenza season

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Keywords

Coinfection • Population • Respiratory viruses

Summary

Introduction. *The 2021/2022 influenza season was not characterised by a well-defined incidence peak. As reported by the Italian National Institute of Health, a high value of incidence of influenza cases was recorded in week 13, but it was still lower than in other influenza seasons. This abnormal circulation was probably due to relaxation of the COVID-19 pandemic restriction measures, such as social distancing, smart-working, home leaning and the use of masks, which greatly reduced the circulation of respiratory-transmitted viruses, including human respiratory syncytial virus (HRSV). The symptoms of SARS-CoV-2 and influenza are quite similar, sharing the human-to-human transmission route via respiratory droplets.*

Methods. *The aim of this study was to estimate the rate of coinfection with influenza viruses and/or HRSV in SARS-CoV-2-positive subjects (N = 940) in a population of central Italy during the 2021/2022 season.*

Results. *A total of 54 cases of coinfection were detected during the study period, 51 cases (5.4%) of SARS-CoV-2 and influenza virus and three cases (0.3%) of SARS-CoV-2 and HRSV coinfection.*

Conclusions. *These results highlight the importance of continuous monitoring of the circulation of influenza virus and other respiratory viruses in the context of the COVID-19 pandemic.*

Introduction

SARS-CoV-2 is a non-segmented, enveloped, positive-sense RNA virus that began its worldwide spread in December 2019 [1]. The World Health Organization (WHO) declared the COVID-19 pandemic on March 2020. The virus spread all year round, showing peaks in winter and when social containment measures were relaxed [2]. Influenza is caused by a segmented, negative-sense RNA virus that gives rise to epidemics, mostly in the winter months. Of the four types of influenza viruses, influenza A (IAV) and B (IBV) are mainly responsible for seasonal influenza. Currently, A/H1N1 and A/H3N2 are the most widespread IAV subtypes circulating in the human population [3]. Human respiratory syncytial virus (HRSV) is a seasonal negative-sense RNA virus and prominent cause of acute lower respiratory tract infections in young children [4].

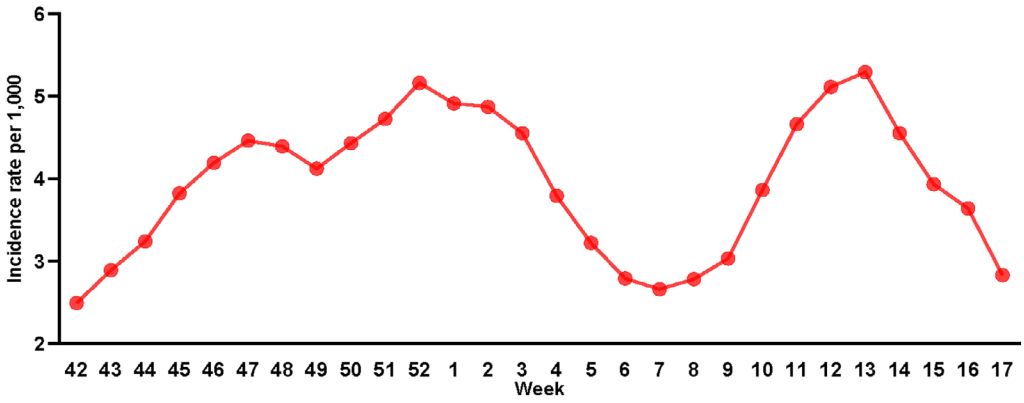
In response to the COVID-19 health emergency and given the absence of specific pharmacological therapies or highly effective vaccines to curb the spread of SARS-CoV-2, many countries adopted non-pharmaceutical mitigation strategies. These strategies included the use of personal protective equipment, implementation of social distancing measures, temporary closure of educational institutions and airports, and mandatory reporting of cases of infection, followed by isolation of affected individuals. This approach passively influenced the seasonal transmission patterns of airborne viruses, including influenza viruses and HRSV [5, 6].

The 2020/2021 influenza season in Italy was characterized by an initial phase of co-circulation of SARS-CoV-2 and influenza viruses, followed by a rapid decline in influenza transmission due to implementation of non-pharmaceutical measures. However, during the 2021/2022 influenza surveillance season (from week 42 of 2021 to week 17 of 2022), an increase in the incidence of influenza was recorded [7]. The epidemiological curve of influenza-like illness (ILI) cases showed a bimodal trend, peaking at week 52 of 2021 and weeks 12-13 of 2022, when positive samples again rose above the epidemic threshold of 10% positivity [8] (Fig. 1). The first wave was characterized as supported mainly by HRSV circulation, while influenza viruses dominated in the second wave [19].

An increasing number of studies show that patients affected with COVID-19 may also be coinfected with other respiratory pathogens [9-11]. Indeed, the coexistence of SARS-CoV-2 and influenza viruses led to cases of coinfection having more severe symptoms than infections with either virus alone [12].

The present study, performed during the 2021/2022 influenza season, investigated the prevalence of influenza or HRSV coinfections in SARS-CoV-2-positive subjects

Fig. 1. Incidence of influenza-like illness in Italy by week during the 2021/2022 influenza season, according to the Italian National Institute of Health [8].



in Tuscany (Italy), with the aim of underlining the importance of continuing epidemiological surveillance of other respiratory viruses in addition to SARS-CoV-2.

Materials and methods

Study design

Oropharyngeal swabs were collected by general practitioners, during the 2021/2022 influenza surveillance season (from week 46 of 2021 to week 17 of 2022) in Siena, Tuscany (Italy), and stored at -80°C. A total of 940 swabs were selected as having previously tested positive for SARS-CoV-2: 742 collected during the first influenza wave (week 46 of 2021 to week 4 of 2022) and 198 during the second (week 5 to week 17 of 2022). Information on the age and sex of the subject was available for 860 swabs. The median age of subjects was 30 years (range 1-65 years), 422 were male and 438 were female. Swabs were divided by age group as follows: 1-10 years (N = 52), 11-20 years (N = 146), 21-30 years (N = 260), 31-40 years (N = 147), 41-50 years (N = 125), and 51-65 years (N = 130). No information on COVID-19 or influenza vaccination status was available. Informed consent was submitted and signed by all patients who voluntarily underwent swabbing

Laboratory analysis

Total RNA was extracted from specimens by QIAamp Viral RNA Mini kit (Qiagen, Hilden, Germany). Real-time reverse transcriptase–polymerase chain reaction tests (RT-PCR) were performed for IAV, IBV and HRSV with Flu/HRSV kit (Siemens) on nasopharyngeal swabs of subjects who had already tested positive for SARS-CoV-2 by COVID-19 HT Screen (Clonit, Abbiategrasso, Italy). At the same time, one-step real-time RT-PCR was performed in a final volume of 25 µL (SuperScript III Platinum One-Step qRT-PCR Kit, Thermo Fisher Scientific, Waltham, MA, USA) to subtype for pandemic influenza virus A/H1N1 (Flu A/pH1N1) and seasonal influenza virus A/H3N2 (Flu A/H3N2) on samples positive for IAV. H3-For Primer: AAGCATTCCYAATGACAAACC, H3-Rev Primer: ATT GCR CCR AAT ATG CCT CTA GT, H3-Probe: Fam – 5' CAG GAT CAC A"T"A TGG GSC CTG TCC CAG – 3' SPACER – BHQ-1 and H1pdm-For Primer: GTG CTA TAA ACA CCA GYC TCC CAT T,H1pdm-Rev Primer: AGA YGG GAC ATT CCT CAA TCC TG, H1pdm-Probe: Fam – 5' TGG CCA GYC "T" CA ATT TTG TGC TTT TTA CAT A - 3' SPACER – BHQ-1, were used.

Statistical analysis

The median ages of the total and influenza-positive populations were calculated. The number of SARS-CoV-2/influenza or HRSV coinfection cases by period of collection (first and second influenza waves) and age group (above or below median age, *i.e.* 30 years) was compared by the Yates corrected chi-square test. Statistical significance was set at $p < 0.05$ (two-tailed test). All statistical analysis was performed using GraphPad Prism 6 software.

Results

A total of 54 cases (5.7%) of coinfection were detected during the study period: 51 cases (5.4%) of SARS-CoV-2 and influenza viruses (43 for IAV and 8 for IBV) and three cases (0.3%) of SARS-CoV-2 and HRSV. Of the influenza cases, 34 cases of IAV were A/H3N2 subtype while the remaining 9 cases were not attributed to a subtype. The 8 cases of IBV were not subtyped.

As reported in Figure 2, most coinfections were detected during the first influenza wave (36/43 cases of IAV, 6/8 cases of IBV and 2/3 cases of HRSV), albeit showing no statistically significant difference with respect to the second wave.

For 860 samples, including all those in which an influenza virus or HRSV coinfection was detected, information on the sex and age of the subjects was available.

Fig. 2. Cases of coinfection with SARS-CoV-2 and human respiratory syncytial (HRSV), influenza A (IAV) or B (IBV) viruses from November 2021 to May 2022. Dashed vertical line separates first (left) and second (right) wave of influenza.

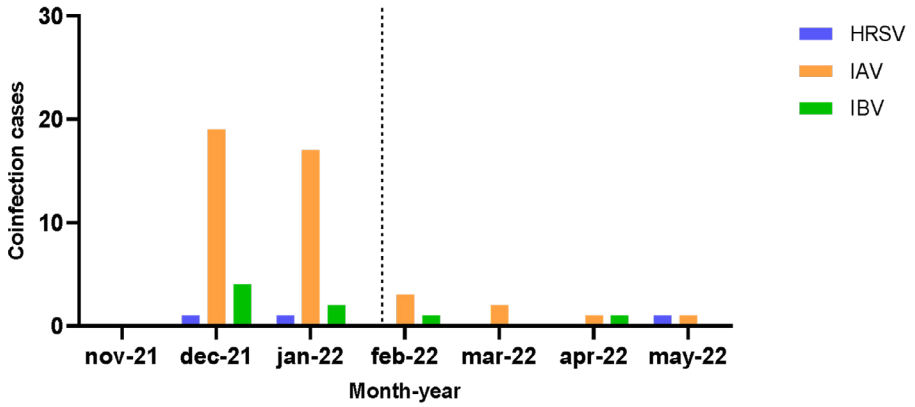
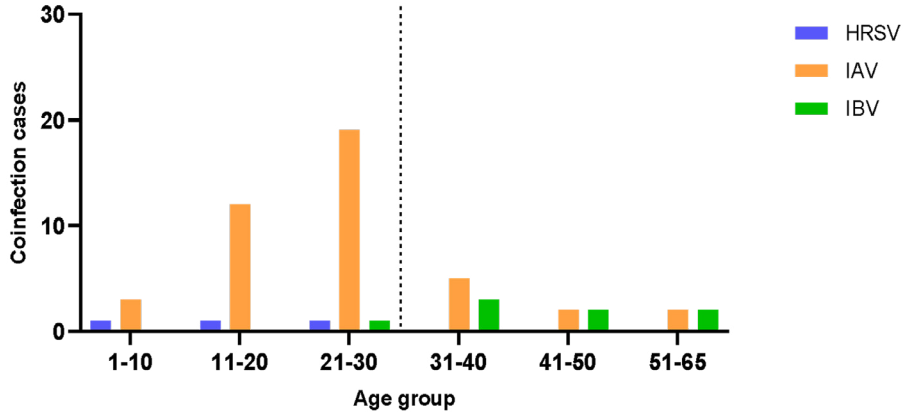


Fig. 3. Cases of coinfection with SARS-CoV-2 and human respiratory syncytial (HRSV), influenza A (IAV) or B (IBV) viruses by age group. Dashed vertical line indicates the median age of the study population (30 years).



No significant difference in the distribution of cases by sex was found, while Figure 3 shows the distribution of coinfection cases by age.

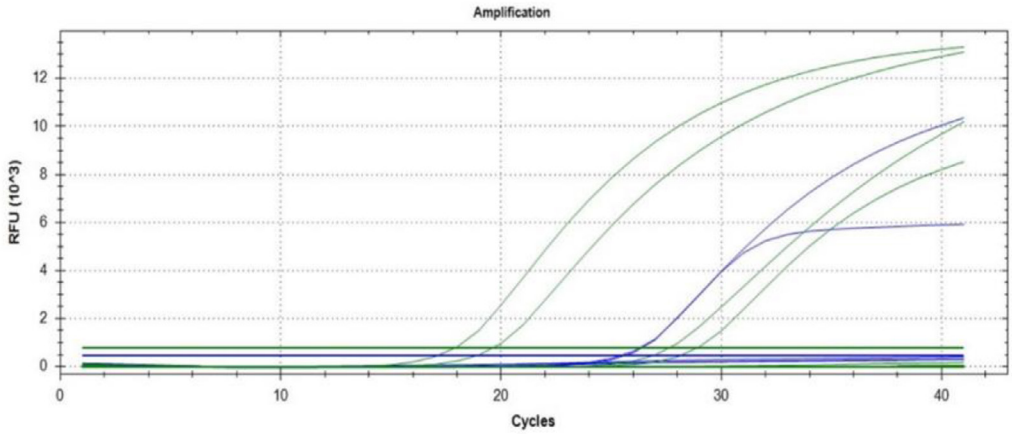
SARS-CoV-2 coinfections with HRSV were only detected in subjects under 30 years of age (median age of positive subjects 14 years), although the difference was not significant. Coinfections with IAV were detected in all age groups, but the prevalence was higher in subjects of 30 years and under (median age of positive subjects 23 years, $p = 0.0009$), while IBV was detected mainly in subjects of 30 years and over (median age of positive subjects 43 years, $p = 0.0494$). Some PCR results regarding Flu/HRSV kit (Siemens) are shown in Figure 4.

Discussion

In December 2019, identification of a new coronavirus in Wuhan, China, demanded a prompt response and global cooperation by health authorities [6]. The pandemic influenced the seasonal transmission patterns of airborne viruses. SARS-CoV-2 shares transmission through direct contact and airborne contagion as well as symptoms, including fever, cough, sore throat, fatigue, nasal congestion and respiratory distress, with the influenza virus, complicating differentiation of the two infections [5, 6]. Cases of coinfection with SARS-CoV-2 and influenza proved to have symptoms that were more severe [12]. After 2019/2020, the incidence of ILI in Italy declined due to non-pharmaceutical actions imposed for SARS-CoV-2. In the 2021/2022 season, an increase in the incidence of infections caused by influenza viruses was observed, with an overall positivity rate of 14.4% [19] although significantly lower than that observed before the COVID-19 pandemic. Indeed, the season was characterized by low circulation of influenza, the first cases being reported in week 52 of 2021. Circulation increased from week 8 of 2022, reaching a maximum in week 12 of the same year, when COVID-19 restrictions were relaxed [13].

In this study, we found a total of three cases of coinfection of SARS-CoV-2 and HRSV and 51 cases of coinfection of SARS-CoV-2 and influenza viruses: 43 cases of IAV and 8 cases of IBV. Ignoring influenza virus type, influenza coinfection cases were detected in 5.4% of the SARS-CoV-2-positive subjects tested in this study, a coinfection rate in line with those reported in other countries [14-16].

Fig. 4. Representative results of PCR. Green fluorescence for Influenza A positive samples, blue fluorescence for HRSV positive sample.



Among IAV cases, 34 were caused by A/H3N2 subtype, in line with Italian and European data reporting it to be the predominant influenza subtype during the 2021/2022 season [17, 18].

The majority of SARS-CoV-2 and influenza coinfections were found during the first wave of the influenza season. A similar distribution was observed in a study conducted in children and adolescents hospitalized in the US, where influenza-associated hospitalizations characterized by influenza and SARS-CoV-2 coinfections were higher in December and January months [20]. IAV and SARS-CoV-2 coinfections were higher in the first months of the season also in a US study conducted in individuals from University of Missouri Health Care [21], suggesting that coinfection with SARS-CoV-2 Omicron variant may have been reduced compared to coinfections with Delta variant, due to different viral antagonism to IAVs.

In a surveillance study conducted on hospitalized subjects in Tuscany during the same season, three cases of SARS-CoV-2 and influenza coinfection were found in March in the second half of the influenza season [17]. The same study reported two cases of HRSV infection, one of which involved coinfection with SARS-CoV-2. Both cases occurred in subjects aged 30 years or under, in line with the results of our study. In contrast to our results, a report by Cong et al in a population older than 18 years, the median age of co-infected persons was older than the fifth year [25]. As reported in few studies, in patients with COVID-19-Influenza co-infection, the need for intervention with mechanical ventilation and hospital stay increase compared with patients infected with only one of the two respiratory viruses, suggesting an aggravation of the disease picture [23, 24]. Although it appears that the copresence of the two viruses does not result in increased mortality [25]

Our study has some limitations. Information on clinical features, medication use and outcomes, as well as vaccination status for COVID-19 and/or influenza was not available and sequencing of SARS-CoV-2- and influenza-positive samples was not performed. In addition, since in Italy administration of live attenuated influenza vaccines (LAIV) are authorised for use in persons aged between 2 and 18 years [22], we cannot exclude detection of influenza antigen from vaccinal strains in younger age groups swabs. Moreover, other respiratory viruses potentially coinfecting with SARS-CoV-2, such as parainfluenza viruses, were not included.

Few studies on respiratory virus epidemiology and coinfections have been conducted in Italy in the 2021/2022 season. The 2021/2022 influenza season was peculiar as it saw the partial resurgence of respiratory viruses after the advent of COVID-19, therefore the characterization of as much as possible the epidemiology of respiratory viruses and coinfections with SARS-CoV-2 is of outmost importance to understand the post-pandemic epidemiology of respiratory viruses.

Given the overlapping symptoms and epidemiology of the influenza virus and SARS-CoV-2, it remains of primary importance to conduct differential diagnosis of these major airborne-transmitted viruses to avert complications related to infection. The use of multiplex RT-PCR tests, as in our study, ensures a timely diagnosis and consequently an appropriate clinical approach to each patient. Despite its limitations, our study underscores the significance of continuous monitoring of the circulation of influenza viruses.

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Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Data availability statement

The data presented in this study are available on request from the corresponding author.

Conflict of interest statement

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Authors' contributions

IM, GM: conceptualization. IM: methodology. IM: validation. SM: formal analysis. GM, IV, LF, C.B: investigation. CMT, IM, IV, EM: resources. SM: data curation. GM: writing-original draft preparation. SM: writing-review and editing. SM: visualization. IM: supervision. IM: project administration. All authors have read and agreed to the published version of the manuscript.

References

[1] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W; China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020;382:727-33. https://doi.org/10.1056/NEJMoa2001017.

[2] Civil Protection Department. Available at: https://www.protezionecivile.gov.it/en/ (Accessed on: 26/05/2022).

[3] Krammer F, Smith GJD, Fouchier RAM, Peiris M, Kedzierska K, Doherty PC, Palese P, Shaw ML, Treanor J, Webster RG, García-Sastre A. Influenza. Nat Rev Dis Primers 2018;4:3. https://doi.org/10.1038/s41572-018-0002-y.

[4] Halabi KC, Wang H, Leber AL, Sánchez PJ, Ramilo O, Mejias A. Respiratory syncytial virus and SARS-CoV-2 coinfections in children. Pediatr Pulmonol 2022;57:3158-60. https://doi.org/10.1002/ppul.26127.

[5] Flerlage T, Boyd DF, Meliopoulos V, Thomas PG, Schultz-Cherry S. Influenza virus and SARS-CoV-2: pathogenesis and host responses in the respiratory tract. Nat Rev Microbiol 2021;19:425-41. https://doi.org/10.1038/s41579-021-00542-7.

[6] Ozaras R, Cirpin R, Duran A, Duman H, Arslan O, Bakcan Y, Kaya M, Mutlu H, Isayeva L, Kebanlı F, Deger BA, Bekeshev E, Kaya F, Bilir S. Influenza and COVID-19 coinfection: report of six cases and review of the literature. J Med Virol 2020;92:2657-65. https://doi.org/10.1002/jmv.26125.

[7] Istituto Superiore della Sanità, Epicentro. Available at: https://www.epicentro.iss.it/influenza/stagione-in-corso (Accessed on: 01/07/2022).

[8] Istituto Superiore della Sanità, Epicentro. Available at: https://www.epicentro.iss.it/influenza/flunews21-22#epi (Accessed on: 25/10/2023).

[9] Bai L, Zhao Y, Dong J, Liang S, Guo M, Liu X, Wang X, Huang Z, Sun X, Zhang Z, Dong L, Liu Q, Zheng Y, Niu D, Xiang M, Song K, Ye J, Zheng W, Tang Z, Tang M, Zhou Y, Shen C, Dai M, Zhou L, Chen Y, Yan H, Lan K, Xu K. Coinfection with influenza A virus enhances SARS-CoV-2 infectivity. Cell Res 2021;31:395-403. https://doi.org/10.1038/s41422-021-00473-1.

[10] Burrel S, Hausfater P, Dres M, Pourcher V, Luyt CE, Teyssou E, Soulié C, Calvez V, Marcelin AG, Boutolleau D. Co-infection of SARS-CoV-2 with other respiratory viruses and performance of lower respiratory tract samples for the diagnosis of COVID-19. Int J Infect Dis 2021;102:10-3. https://doi.org/10.1016/j.ijid.2020.10.040.

[11] Xiaojuan Z, Yiyue G, Tao W, Kangchen Z, Yin C, Bin W, Fengcai Z, Baoli Z, Lunbiao C. Co-infection with respiratory pathogens among COVID-2019 cases. Virus Res 2020;285:198005. https://doi.org/10.1016/j.virusres.2020.198005.

[12] Uyeki TM, Hui DS, Zambon M, Wentworth DE, Monto AS. Influenza. Lancet 2022;400:693-706. https://doi.org/10.1016/S0140-6736(22)00982-5.

[13] Rapporto Influnet. Available at: https://www.iss.it/site/rmi/influnet/pagine/rapportoinflunet.aspx (Accessed on: 09/02/2023).

[14] Steponavičienė A, Burokienė S, Ivaškevičienė I, Stacevičienė I, Vaičiūnienė D, Jankauskienė A. Influenza and respiratory syncytial virus infections in pediatric patients during the COVID-19 pandemic: a single-center experience. Children (Basel) 2023;10:126. https://doi.org/10.3390/children10010126.

[15] Trifonova I, Christova I, Madzharova I, Angelova S, Voleva S, Yordanova R, Tcherveniakova T, Krumova S, Korsun N. Clinical significance and role of coinfections with respiratory pathogens among individuals with confirmed severe acute respiratory syndrome coronavirus-2 infection. Front Public Health 2022;10:959319. https://doi.org/10.3389/fpubh.2022.959319. Saeedeh. E.; Mojtaba. K.; Barat. B.; Nayeb. F.D.; Zahra. N.; Tahereh. N.; Faezeh. S. The circulation of common respiratory viruses and their co-infection with severe respiratory syndrome coronavirus 2 before and after coronavirus disease of 2019 vaccination. Jundishapur J Microbiol 2022;15:e133326. Https://doi.org/10.5812/jjm-133326.

[16] Milano G, Capitani E, Camarri A, Bova G, Capecchi PL, Lazzeri G, Lipari D, Montomoli E, Manini I. Surveillance of influenza and other airborne transmission viruses during the 2021/2022 season in hospitalized subjects in Tuscany, Italy. Vaccines (Basel) 2023;11:776. https://doi.org/10.3390/vaccines11040776.

[17] Istituto Superiore della Sanità, Epicentro. Available at: https://www.epicentro.iss.it/influenza/flunews#vir (Accessed on: 26/05/2022).

[18] Istituto Superiore della Sanità, Epicentro. Available at: https://www.epicentro.iss.it/ben/2022/4/virus-influenzali-vaccinazioni-influnet-2021-2022 (Accessed on: 19/12/2023).

[19] Adams K, Tastad KJ, Huang S, Ujamaa D, Kniss K, Cummings C, Reingold A, Roland J, Austin E, Kawasaki B, Meek J, Yousey-Hindes K, Anderson EJ, Openo KP, Reeg L, Leegwater L, McMahon M, Bye E, Poblete M, Landis Z, Spina NL, Engesser K, Bennett NM, Gaitan MA, Shiltz E, Moran N, Sutton M, Abdullah N, Schaffner W, Talbot HK, Olsen K, Staten H, Taylor CA, Havers FP, Reed C, Budd A, Garg S, O'Halloran A, Brammer L. Prevalence of SARS-CoV-2 and influenza coinfection and clinical characteristics among children and adolescents aged < 18 years who were hospitalized or died with influenza – United States, 2021-22 influenza season. MMWR Morb Mortal Wkly Rep 2022;71:1589-96. https://doi.org/10.15585/mmwr.mm7150a4.

[20] Tang C, Boftsi M, Staudt L., Jane A. McElroy e, Tao Li f, Duong S, Adrienne Ohler g, Detlef Ritter h, Richard Hammer d,h, Jun Hang f, XiuFeng Wan. SARS-CoV-2 and influenza co-

infection: a cross-sectional study in central Missouri during the 2021-2022 influenza season. Virology 2022:576:105-10.https://doi.org/10.1016/j.virol.2022.09.009.

[21] Ministero della Salute, Available at: https://www.salute.gov.it/portale/p5_1_2.jsp?id=103&lingua=italiano#:~:text=%C3%88%20indicato%20dai%2018%20anni%20di%20et%C3%A0.&text=Il%20vaccino%20vivo%20attenuato%20%C3%A8,tra%202%20e%2018%20anni (Accessed on 19/12/2023).

[22] Garg I, Gangu K, Shuja H, Agahi A, Sharma H, Bobba A, Nasrullah A, Chourasia P, Pal S, Sheikh AB, Shekhar R. COVID-19 and influenza coinfection outcomes among hospitalized patients in the United States: a propensity matched analysis of national inpatient sample. Vaccines (Basel) 2022;10:2159. https://doi.org/10.3390/vaccines10122159.

[23] Swets MC, Russell CD, Harrison EM, Docherty AB, Lone N, Girvan M, Hardwick HE; ISARIC4C Investigators; Visser LG, Openshaw PJM, Groeneveld GH, Semple MG, Baillie JK. SARS-CoV-2 co-infection with influenza viruses, respiratory syncytial virus, or adenoviruses. Lancet 2022;399:1463-4. https://doi.org/10.1016/S0140-6736(22)00383-X.

[24] Cong B, Deng S, Wang X, Li Y. The role of respiratory co-infection with influenza or respiratory syncytial virus in the clinical severity of COVID-19 patients: a systematic review and meta-analysis. J Glob Health 2022;12:05040. https://doi.org/10.7189/jogh.12.05040.

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HEALTH PROMOTION

Knowledge, attitudes, and practices related to the prevention of adverse pregnancy outcomes among samples of females in Al-Suwaira city, Wasit Governorate, Iraq

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Keywords

Attitude • Iraq • Knowledge • Practice • Pregnancy outcomes • Reproductive-aged females

Summary

Introduction. *Adverse pregnancy outcomes pose serious health risks to both periconceptional women and newborns. This study aimed to investigate the levels of knowledge, attitudes, and practice (KAP) toward adverse pregnancy outcomes among women of reproductive age in Al-Suwaira, Wasit governorate, Iraq.*
Methods. *During November 2021 to February 2022, cross-sectional research of randomly selected women was performed. The KAP was evaluated with a standard, self-administered questionnaire. The outcomes were described using a descriptive analysis.*
Results. *The questionnaire was completed by 118 women. Participants had good knowledge and positive attitudes and practices toward adverse pregnancy outcomes. The findings revealed that the majority of participants were between the ages of 20 and 25 (n = 57, 48.3%) and had a Bachelor's degree (n = 106, 89.8%). Knowledge gaps were discovered in the areas of the danger of pregnancy at a young age of less than 17 years (30.5%), the link between lack of maternal education and poor births (24.6%), and the influence of drug misuse on the fetus (17.8%). The participants learn more around pregnancy-related risk factors via internet (n = 38, 32.2%) and university (n = 34, 28.8%).*
Conclusions. *The participants in this study had good knowledge, positive attitude, and positive practice regarding adverse pregnancy outcomes. However, there were some knowledge gaps. Therefore, to raise awareness among local women, it seems advisable to strengthen and strictly apply awareness-raising plans.*

Introduction

Adverse pregnancy outcomes pose a serious health risk to both periconceptional women and newborns. These conditions, which account for more than half of maternal mortality, include sepsis, hypertensive diseases, and pregnancy hemorrhage [1]. The World Health Organization (WHO) estimates that problems related to pregnancy or childbirth cost the lives of more than 830 women worldwide every day [2]. Indicators of maternal health around the world include adverse pregnancy outcomes such as miscarriages, abortions, stillbirths, and preterm deliveries [3]. No obvious causes are known for 75% of these outcomes, but several etiologic risk factors have been identified. Non-obstetric risk factors include poor socio-economic status, maternal malnutrition, illiteracy, maternal age < 20 and > 35 years, heavy physical work, cigarette smoking, long-distance travel, and trauma. Obstetric risk factors associated with these outcomes include cervical incompetence, multiple gestations, short birth intervals, abortions, preterm premature rupture of membrane (PPROM), and previous preterm birth [4]. Several other medical conditions have also been associated with these outcomes, including diabetes mellitus, urinary and genital tract infections, and psychological stress [4].

Maternal mortality rates are 100 times higher in most low-income nations than in high-income ones. In addition, many middle- and low-income countries have notably different prenatal outcomes than high-income countries [5, 6]. However, it is possible that our already murky understanding of the true incidence of poor pregnancy outcomes in underdeveloped countries is further clouded by under-reporting and under-recording due to the prevalence of home deliveries there [7]. Adopting prenatal care methods for high-risk women has drastically reduced the number of unwanted birth outcomes across the industrialized countries. Therefore, the identification of risk factors associated with pregnancy outcomes, together with the promotion of health facilities that address and manage these factors, can significantly reduce the number of adverse outcomes in developing countries, including Iraq [7].
Increasingly, data show that antenatal care has a positive impact on improving prenatal care for both mother and newborn. Women are less likely to seek prenatal care if they are not informed about the risk factors associated with adverse perinatal outcomes or if they have negative attitudes about the importance of protecting themselves and their future children from these risks [8].
In Iraq, all parts of the country are affected by war and sanctions, and pregnant women are a particularly

vulnerable group. They face the consequences of poor nutrition and even malnutrition, low socio-economic standards, infections, stress and anxiety. All these risk factors are associated with an increased adverse pregnancy outcomes. Therfore, preventive measures are required to limit and mitigate the occurrence of these undesirable outcomes. Primary prevention, which includes certain health promotion methods, safety precautions, and the identification and control of environmental contaminants, is considered a key factor in eliminating the adverse pregnancy outcomes. Hence, to provide safeguards and eventually completely prevent the occurrence of these adverse pregnancy consequences in Iraq, particularly in Al-Suwaira city, this study sought to assess the knowledge, attitude, and practice (KAP) interconnected to reduce the risk of unfavorable prenatal outcomes among fertile-aged females from Al-Suwaira city, Wasit Governorate, Iraq.

Methods

Ethical consideration

This study was approved by the Ethics Committee of theMiddle Technical University, Baghdad, Iraq (7.7.2021) in accordance with the Helsinki Declaration of 1975. The written informed consent was obtained from all participants.

Study design, site and participants

In this descriptive cross-sectional study during November 2021 and February 2022, reproductive-aged females in Al-Suwaira city, Wasit Governorate, Middle East of Iraq were investigated for their KAP about adverse pregnancy outcomes. These participants have varying levels of experience, ranging from an inability to read and write to a bachelor's degree.

Data collection

A self-administered questionnaire was analyzed by qualified contributors according to their points of view, and research students collected the data and answers to all questions from the participants. The questionnaire was pre-tested. The original manuscript was forwarded to three professionals who were asked to comment on the relevance, simplification, and importance of the topic after a thorough review for content authenticity. It comprised a total of 5 sections. In the first section, the participants' age, occupational status, educational background, marital status, and place of residence were examined. Five questions in the second section assessed the samples' knowledge about avoiding adverse pregnancy outcomes. The subjects' familiarity with the topic was determined by information questions. Information such as the effects of malnutrition during pregnancy, pregnancy at a young age, inadequate prenatal care, lack of maternal education, and drug misuse during pregnancy on maternal and fetal health were assessed. Attitudes were assessed using six statements. Practices of participants were assessed based on four questions. The final section examined respondents' sources of information on pregnancy risk factors.

Data analysis

Using SPSS version 26 (IBM Corporation, Armonk, NY, USA), the participant responses were examined. The demographic data was expressed using descriptive analysis in the form of frequencies and percentages, mean scores, and standard deviation. The chi-square test was used to evaluate any significant association among different variables.

Score calculation:.

- Regarding the knowledge:
  An assessment of knowledge agreed by awarding a score of (2) for the correct answer and (1) for the incorrect answer
  Number of questions: 5
  Minimum = 5
  Maximum = 10
  Medium = 7.5
  The mean score was calculated for each question and those below the mean score were considered poor, above or equal to 10 were considered acceptable and good.
- Regarding attitudes:
  An assessment of attitudes agreed by awarding a score of (3) for the answer by (agree) and (2) for the answer by (neutral) and (1) for the answer by (disagree)
  Number of questions: 6
  Minimum = 6
  Maximum = 18
  Medium = 12
  The mean score was calculated for each question and those below the mean score were considered poor, above or equal to 18 were considered acceptable and good.
- Regarding practices:
  A scoring of practices agreed by assigning a score of (3) for the answer by (always), (2) for the answer by (sometimes), and (1) for the answer by (never)
  Number of questions: 4
  Minimum = 4
  Maximum = 12
  Medium = 8
  The mean score was calculated for each question and those below the mean score were considered poor, above or equal to 12 were considered acceptable and good.

Results

Demographic information of the participants

A total of 118 individuals completed the survey. Almost all participants were between 20 and 25 years old (n = 57, 48.3%), while only a few participants were over 30 years old (n = 2, 1.7%). Concerning to qualifications,

Tab. I. Demographic information of the contributors of this study.

Demographic information		Number	(%)
Age groups	< 20	49	41.5
	(20-25)	57	48.3
	(25-30)	10	8.5
	> 30	2	1.7
	Total	118	100.0
Qualifications	Unable to read and write	2	1.7
	Primary school	3	2.5
	Secondary school	7	5.9
	Bachelor's	106	89.8
	Total	118	100.0
Occupation status	Government employee	6	5.1
	Student	107	90.7
	Housewife	5	4.2
	Others	0	0.0
	Total	118	100.0
Marital status	Married	29	24.6
	Unmarried	89	75.4
	Total	118	100.0
Residence	Rural	33	28.0
	Urban	85	72.0
	Total	118	100.0

almost all participants had bachelor's degree (n = 106, 89.8%), while very few participants could not read and write (n = 2, 1.7%). Taking occupation status into account, students (n = 107, 90.7%) were the foremost respondents in this study. The results of a survey of married respondents (n = 29, 24.6%) were lower than those of single participants (n = 89, 75.4%). The proportion of responses from rural and urban areas were (n = 33, 27.96%) and (n = 85, 72.03%), respectively (Tab. I).

Knowledge of participants towards the risk factors for adverse pregnancy outcomes

Overall, the majority of participants demonstrated a good knowledge of pregnancy-related risk factors. The results revealed that the majority of the respondents (95.8%, n = 113) could correctly assess that malnutrition during pregnancy can lead to small size of the fetus, miscarriage or other congenital disorders, and that the the participants' knowledge on this issue was good. Nearly (53.4%, n = 63) of participants answered incorrectly that pregnancy under 17 years of age is less likely to lead to developmental problems in children, even if it increases the likelihood of a caesarean section at birth, and participants' knowledge of this question was poor. Regarding antenatal care, a high percentage

Tab. II. Study participants' knowledge of risk factors for poor pregnancy outcomes in Al-Suwaira city, Wasit Governorate, Middle East of Iraq.

List	General information about risk factors for adverse pregnancy outcomes items					
1	Malnutrition during pregnancy can lead to a small baby, abortion, or other complications					
	Rating	N	%	Mean	SD	Assessment
	Incorrect	5	4.2	1.958	0.202	Good
	Correct	113	95.8			
	Total	118	100.0			
2	Pregnancy at a young age, less than 17 years, is less likely to result in children with developmental problems, although it does increase the likelihood of a caesarean section at birth					
	Rating	N	%	Mean	SD	Assessment
	Incorrect	63	53.4	1.466	0.501	Poor
	Correct	55	46.6			
	Total	118	100.0			
3	Inadequate prenatal care would result in the mother's death owing to complications during birth					
	Rating	N	%	Mean	S.d.	Assessment
	Incorrect	23	19.5	1.805	0.398	Good
	Correct	95	80.5			
	Total	118	100.0			
4	Poor deliveries might be caused by a lack of maternal education.					
	Rating	N	%	Mean	SD	Assessment
	Incorrect	35	29.7	1.703	0.459	Good
	Correct	83	70.3			
	Total	118	100.0			
5	Drug misuse during pregnancy might cause the baby's brain to be damaged					
	Rating	N	%	Mean	SD	Assessment
	Incorrect	75	63.6	1.364	0.483	Poor
	Correct	43	36.4			
	Total	118	100.0			
N: Number, Level of assessment (poor < 1.5), (good ≥ 1.5), SD: Standard deviation.						

Tab. III. Study participants' attitudes toward negative pregnancy outcomes prevention practices in Al-Suwaira city, Wasit governorate, Middle East of Iraq.

List	General information about negative pregnancy outcomes prevention practices items					
	There's nothing wrong with getting pregnant every year or in a short period of time					
	Rating	**N**	**%**	**Mean**	**SD**	**Assessment**
1	Disagree	37	31.4	0.686	0.466	Positive
	Agree	81	68.6			
	Total	118	100.0			
	I am willing to have a caesarean section if necessary to avoid difficulties during delivery					
	Rating	**N**	**%**	**Mean**	**SD**	**Assessment**
2	Disagree	68	57.6	0.424	0.496	Negative
	Agree	50	42.4			
	Total	118	100.0			
	My society sees nothing wrong with having children as young as 17 years old					
	Rating	**N**	**%**	**Mean**	**SD**	**Assessment**
3	Disagree	30	25.4	0.746	0.437	Positive
	Agree	88	74.6			
	Total	118	100.0			
	I don't believe a prenatal checkup is required					
	Rating	**N**	**%**	**Mean**	**SD**	**Assessment**
4	Disagree	14	11.9	0.881	0.325	Positive
	Agree	104	88.1			
	Total	118	100.0			
	I don't believe that education is necessary for safe delivery					
	Rating	**N**	**%**	**Mean**	**SD**	**Assessment**
5	Disagree	33	28.0	0.720	0.451	Positive
	Agree	85	72.0			
	Total	118	100.0			
	I have no objections to taking folic acid before and during pregnancy, as it is prescribed					
	Rating	**N**	**%**	**Mean**	**SD**	**Assessment**
6	Disagree	74	62.7	0.373	0.486	Negative
	Agree	44	37.3			
	Total	118	100.0			

N: Number; Level of assessment (poor ≤ 0.5), (good ≥ 0.5); SD: Standard deviation

of respondents (80.5%, n = 95) correctly answered that inadequate antenatal care may lead to the mother's mortality as a result of complications during delivery and Knowledge of participants towards this question was good. On the other hand, 70.3% of the participants answered correctly that insufficient maternal education can lead to poor delivery and the knowledge of the participants on this question was good. Also, 75 (63.8%) participants answered incorrectly and less than half of them (36.4%, n = 43) believed that drug use in early pregnancy leads to brain damage in the baby. The participants' knowledge of pregnancy-related risk factors was described poor, as shown in Table II. The overall knowledge of risk factors for adverse pregnancy outcomes was good (64%).

Attitudes of participants towards the practices for preventing harmful prenatal effects

Our results showed that a large percentage of respondents (68.6%, n = 81) agree that it is not wrong to get pregnant every year or within a short period of time, and a small percentage of participants (31.4%, n = 37) disagree. The assessment of this trend was positive. Fifty (42.4%) respondents stated that they had no problem with having a caesarean section to prevent birth problems, while about 68 (57.6%) respondents disagreed. The assessment of this trend was negative. A total of 88 (74.6%) respondents agreed that their culture has no objection to having children at the age of 17, while 30 (25.4%) respondents disagreed that their culture has no objection to having children at the age of seventeen. The assessment of this direction was positive. On the other hand, a very small percentage of the respondents (11.9%, n = 14) felt that prenatal screening was not necessary, while 104 (88.1%) respondents felt that prenatal screening was necessary. The assessment of this trend was positive. Also, 85 (72.0%) women believed that education is a necessary factor for a safe delivery, while 33 (28%) of them did not. The assessment of this trend was positive. Moreover, 74 (62.7%) respondents disagreed with the use of folic acid before and during pregnancy, while 44 (37.3%) respondents agreed. The assessment of this trend was negative (Tab. III).The general public was in favour of measures to reduce the risk of adverse pregnancy outcomes (64%).

Tab. IV. Study participants' practices to prevent adverse pregnancy outcomes in Al-Suwaira city, Wasit Governorate, Middle East of Iraq.

List	General information about practices to prevent adverse pregnancy outcomes items					
1	When I'm pregnant, I try to avoid coming to the health center for antenatal care					
	Rating	N	%	Mean	SD	Assessment
	No	87	73.7	2.695	0.547	Good
	Sometimes	26	22.0			
	Yes	5	4.2			
	Total	118	100.0			
2	I participate in community and clinic-based maternal health education and awareness programs					
	Rating	N	%	Mean	SD	Assessment
	No	36	30.5	1.958	0.756	Acceptable
	Sometimes	51	43.2			
	Yes	31	26.3			
	Total	118	100.0			
3	During my pregnancy, I try to stay away from drugs that don't require a prescription					
	Rating	N	%	Mean	SD	Assessment
	No	75	63.6	1.602	0.849	Poor
	Sometimes	15	12.7			
	Yes	28	23.7			
	Total	118	100.0			
4	I'm not used to taking folic acid as directed during and before pregnancy to avoid unintended problems					
	Rating	N	%	Mean	SD	Assessment
	No	71	60.2	2.483	0.701	Good
	Sometimes	33	28.0			
	Yes	14	11.9			
	Total	118	100.0			

N = Number, level of assessment (poor = 1-1.66), (acceptable = 1.67-2.33), (good ≥ 2.34), SD = Standard deviation

Participants' practices to prevent adverse pregnancy outcomes

The majority of respondents (73.7%, n = 87) were in favor of frequent visits to antenatal health care facilities during pregnancy to avoid negative pregnancy outcomes. Likewise, the majority of them (43.2%, n = 51) occasionally participate in clinical and community-based maternal health education and awareness programs. Sixty-three percent of respondents (n = 75) do not try to avoid taking unapproved medications during pregnancy, and sixty-two percent of respondents (n = 71) think it is a good idea to take folic acid during pregnancy (Tab. IV). Overall, participants' practices to prevent adverse pregnancy outcomes was good (57%).

Information sources of respondents towards negative pregnancy outcomes

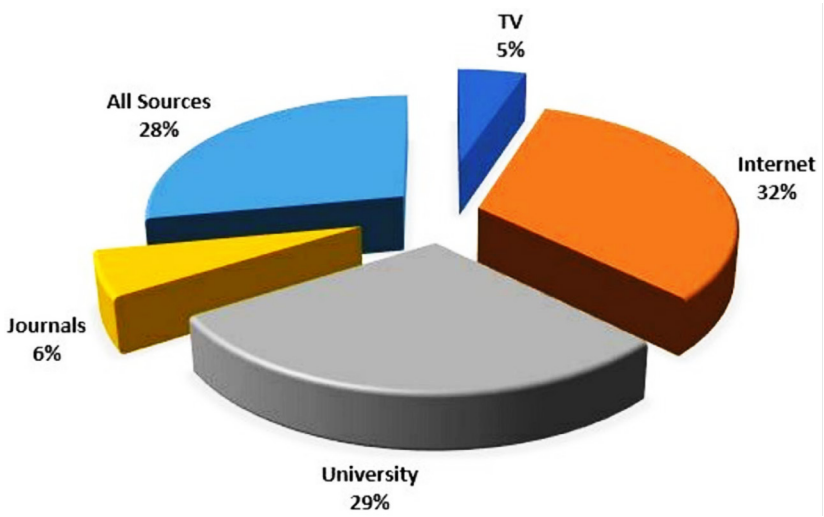
Figure 1 showed that participants primarily used the internet (32.2%, n = 38) and university (28.8%, n = 34) to obtain information about the risks associated with having children. Around 12.7% (n = 15) also obtained information via other media such as television, magazines, and newspapers.

Discussion

Adverse pregnancy outcomes pose serious health risks to both perinatal moms and the newborns. Most of the 118 women who provided information in this study were between 20 and 25 years old and had a bachelor's degree. In accordance with the findings of the study by Ibtehaj et al. [9], the majority of respondents in our survey (95.2%, n = 113) demonstrated correct knowledge that maternal malnutrition during pregnancy can lead to preterm birth, abortion, or other congenital problems. However, our findings were in contrast to the previous reports from Nigeria [1, 8].

One-third of those surveyed by Ibtehaj et al. [9] agreed with this, in contrast to only 28 individuals in the Nigerian survey [8], our results showed that 55 (46.6%) participants recognized that pregnancy at a younger age (under 17 years) is less likely to result in children with developmental problems, even if it increases the likelihood of caesarean section at birth. The prevalent culture of early marriage in our area, as well as the need for constant awareness of the risk of having an child when marrying young, could be the cause of the respondents' inadequate knowledge. In relation to prenatal care, a large percentage of respondents (80.5%) correctly identified that poor prenatal care would lead to maternal death due to postpartum complications, which was consistent with other findings from Nigeria [1,8]. Respondents' awareness of this fact is promising and could motivate them to start prenatal care to reduce the chance of adverse pregnancy outcomes. Only about a quarter of respondents were aware that poor birth outcomes can be caused by inadequate maternal education. According to previous findings from Nigeria [1], only 43 (36.4%) participants stated that drug

Fig. 1. Information sources of participants about negative pregnancy outcomes.



use in early pregnancy leads to cognitive impairment of the fetus [1]. In this region, there are still many gaps in health education regarding awareness of risk factors that influence poor pregnancy outcomes, as this research shows that a better understanding of risk factors will influence the avoidance practices of respondents.

Ibtehaj et al. [9] found that more than half of the respondents considered multiple pregnancies within a short period of time unacceptable. However, our findings that respondents had positive attitudes towards efforts to reduce the risk of poor perinatal outcomes contradict these anecdotes. Only a minority of participants (31.4%) in this survey found nothing wrong with having multiple pregnancies in a short period of time. Also, our results were in contrast to previous studies from Nigeria and India [1, 8, 10]. To reduce newborn and child mortality rates and promote mother health, the WHO recommends that birth intervals should be at least two to three years apart. Nevertheless, differences in birth intervals are closely connected with both children and maternal mortality [11]. Like the previous group, roughly 50 (42.4%) respondents were firmly convinced that they would be willing to have a caesarean section if necessary to avoid difficulties during delivery. This was in contrast to the majority of respondents in the earlier surveys who had a positive attitude towards safe delivery [1,8]. Also, the results of a survey conducted in Saudi Arabia to assess participants' knowledge and attitudes towards risk factors affecting pregnancy outcomes were not consistent with the results of this study in terms of respondents' attitudes towards preventive measures for adverse pregnancy outcomes [9]. However, in contrast to the findings of previous studies, 30 of them (25.4%) stated that having children as young as 17 years old was not considered a problem in their culture [1, 8]. To change women's attitudes towards early marriage, we need to address this widespread problem in our country. Moreover, only 2.5% of the respondents indicated that they did not think prenatal check-up was necessary and therefore delivered in a church or mosque, while the majority of respondents (88.1%) disagreed, which was consistent with the positive attitude of respondents in a previous study from Nigeria [8]. This emphasizes the need for education about prenatal checkup education, because without it, this population will continue to expose itself to the risk of adverse prenatal outcomes. Our results showed that almost all participants (72%) in this survey believed that education was important for safe delivery and more than half of the respondents (62.7%) had experienced problems with folic acid intake in the period before and during pregnancy, which was in contrast to earlier findings [1, 12, 13]. Our findings suggest that maternal education is highly valued in this city and could contribute to a reduction in the severity of poor pregnancy outcomes.

The majority of respondents (73.7%) support frequent visits to antenatal health care facilities when a woman is pregnant and almost all (43.2%) rarely participate in neighborhood and clinic-based reproductive health teaching and outreach initiatives. When it comes to the habit of taking folic acid supplements during pregnancy, almost half of all respondents (60.2%) are in favor of doing so. The majority of respondents (63.6%) do not avoid taking over-the-counter drugs during pregnancy. With the exception of taking over-the-counter medications, respondents in our survey showed a rather adequate level of knowledge and behavior towards preventive activities overall. Thus, the gaps in knowledge about risk factors and their negative behaviors need to be positively filled for a strategy to reduce the likelihood of negative prenatal outcomes to be successful.

Our findings revealed that most participants obtained information about the risks associated with having children on the internet (n = 38; 32.2%), at universities (n = 34; 28.8%), and on other sources (n = 33; 27.9%). With the proliferation of communication channels, the internet has become the first port of call for most people to find out about such developments. It is

important to note that the results of this study are not generalizable to other settings, even though they were collected in a large metropolitan city in Wasit province. In addition, the majority of participants were college-educated women, demonstrating the value of reviewing a large sample size across regions to shed light on this problem. Despite the caveats we've found, our results have significant implications for future study and the design of protective measures. The findings of this study may have a significant impact on the design of future strategies to educate and disseminate information to the public in Iraq, and more specifically in Al-Suwaira city, with the aim of improving the ability of residents to prevent and cope with the negative outcomes mentioned above.

Limitations of the study

The small sample size was one of the limitations of this study. Also, the results of this study cannot be generalized to the entire population since this was a single center research.

Conclusions

The findings of this research suggest that the majority of participants were aged < 20-25 years (n = 57, 48.3%), and had Bachelor's degree (n = 106, 89.8%). In addition, contributors showed good knowledge about the risk factors for poor pregnancy outcomes. Overall, the majority of the participants exhibited good knowledge about pregnancy-related risk factors. In general, the overwhelming bulk of respondents had favorable impressions of negative pregnancy outcomes prevention practices. Even though the people's knowledge about pregnancy-related risk factors was good, their overall practices to prevent adverse pregnancy outcomes indicate that there is still a gap in the achievement of their knowledge. Therefore, and to achieve the WHO worldwide plan of ending all avoidable fatalities of women, children, and teenagers and ensuring their well-being, it is strongly recommended that emphasis be placed on increasing health awareness and education programs for reported inadequate prevention measures.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

All authors contributed to the study conception and design. IDS, MHGK, and SSA participated in the design of the study. IDS and AMT performed data collection, wrote the manuscript, and helped with statistical analysis. AMT and SSA edited the manuscript. All authors read and approved the final manuscript.

References

[1] Afolabi IB, Babatunde AA, Mujeeb S, Yahaya SS, Abaku A, Muonagolu NJ. Knowledge, attitude and practice of adverse pregnancy outcomes prevention among women of reproductive age in Nasarawa Local Government Area, Kano State, Nigeria. Open J Epidemiol 2021;11:501-16. https://doi.org/10.4236/ojepi.2021.114040.

[2] Alkema L, Chou D, Hogan D, Zhang S, Moller AB, Gemmill A, et al. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. Lancet. 2016;387:462-74. https://doi.org/10.1016/S0140-6736(15)00838-7.

[3] Ahinkorah BO, Seidu AA, Ameyaw EK, Budu E, Bonsu F, Mwamba B. Beyond counting induced abortions, miscarriages and stillbirths to understanding their risk factors: analysis of the 2017 Ghana maternal health survey. BMC Pregnancy Childbirth 2021;21:140. https://doi.org/10.1186/s12884-021-03633-8.

[4] Al-Dabbagh SA, Al-Taee WY. Risk factors for pre-term birth in Iraq: a case-control study. BMC Pregnancy Childbirth 2006;6:1-7. https://doi.org/10.1186/1471-2393-6-13.

[5] Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, Shackelford KA, Steiner C, Heuton KR, et al. Global, regional, and national levels and causes of maternal mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2014;384:980-1004. https://doi.org/10.1016/S0140-6736(14)60696-6.

[6] McDonald CR, Weckman AM, Wright JK, Conroy AL, Kain KC. Pregnant women in low-and middle-income countries require a special focus during the COVID-19 pandemic. Front Glob Women's Health 2020;1:564560. https://doi.org/10.3389/fgwh.2020.564560.

[7] Sultani HJ, AL-Obaidi HO, Shabbani GJ. The Incidence rate and risk factors of antenatal stillbirth in Al-Diwaniyah Province at the mid-euphrates region of Iraq: Cross-sectional study. J Popul Ther Clin Pharmacol 2021;28:7-13. https://doi.org/10.15586/jptcp.2021.v28i1.003.

[8] Eni-Olorunda T, Akinbode OO, Akinbode AO. Knowledge and attitude of mothers on risk factors influencing pregnancy outcomes in Abeokuta South Local Government Area, Ogun State. EurSci J 2015;11:313-24.

[9] Ibtehaj AH, Al Hanof AH, Seetah AH, Hessa AH, Thekra AH, Nawal AA, et al. Knowledge and attitude of mothers on risk factors influencing pregnancy outcomes in Qassim, Saudi Arabia: a cross-sectional study. Egypt J Hosp Med 2018;71:3487-91. https://doi.org/10.12816/0047665.

[10] Bhalotra S, Van Soest A. Birth-spacing, fertility and neonatal mortality in India: Dynamics, frailty, and fecundity. J Economs 2008;143:274-90. https://doi.org/10.1016/j.jeconom.2007.10.005.

[11] MOH. Ghana Maternal Health Survey Report. Ghana Health Service Annual Report. 2007. Available at: https://www.moh.gov.gh/wp-content/uploads/2016/02/2007-GHS-annual-report.pdf (Accessed on: 30/01/2023).

[12] Li D, Huang L, Yang W, Qi C, Shang L, Xin J, et al. Knowledge, attitude and practice level of women at the periconceptional period: a cross-sectional study in Shaanxi China. BMC Pregnancy Childbirth 2019;19:326. https://doi.org/10.1186/s12884-019-2481-6.

[13] Temel S, Erdem Ö, Voorham TA, Bonsel GJ, Steegers EA, Denktaş S. Knowledge on preconceptional folic acid supplementation and intention to seek for preconception care among men and women in an urban city: a population-based cross-sectional study. BMC Pregnancy Childbirth 2015;15:340. https://doi.org/10.1186/s12884-015-0774-y.

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HEALTH PROMOTION

Is social media our new quitline? A descriptive study assessing youtube coverage of tobacco cessation

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Keywords

Smoking cessation • Quit smoking • Social media • YouTube • Health education • Health communication • Smoke-free

Summary

Background. *Tobacco use and exposure are leading causes of morbidity and mortality worldwide. In the past decade, educational efforts to reduce tobacco use and exposure have extended to social media, including video-sharing platforms. YouTube is one of the most publicly accessed video-sharing platforms.*
Purpose. *This cross-sectional descriptive study was conducted to identify and describe sources, formats, and content of widely viewed YouTube videos on smoking cessation.*
Methods. *In August to September 2023, the keywords "stop quit smoking" were used to search in YouTube and identify 100 videos with the highest view count.*
Results. *Collectively, these videos were viewed over 220 million times. The majority (n = 35) were posted by nongovernmental/organization sources, with a smaller number posted by consumers (n = 25), and only eleven were posted by governmental agencies. The format used in the highest number of videos was the testimonial (n = 32 videos, over 77 million views). Other popular formats included animation (n = 23 videos, over 90 million views) and talk by professional (n = 20 videos, almost 43 million views). Video content included evidence-based and non-evidence-based practices. Evidence-based strategies aligned with U.S. Public Health Service Tobacco Treatment Guidelines (e.g. health systems approach in tobacco treatment, medication management). Non-evidence-based strategies included mindfulness and hypnotherapy. One key finding was that environmental tobacco exposure received scant coverage across the videos.*
Conclusions. *Social media such as YouTube promises to reach large audiences at low cost without requiring high reading literacy. Additional attention is needed to create videos with up-to-date, accurate information that can engage consumers.*

Introduction

Tobacco use is one of the leading preventable causes of disease, premature death, lost productivity, and healthcare costs. Tobacco use exerts an immense financial burden on the healthcare system in the United States. Costs incurred for treatment from illnesses and lost productivity attributed to tobacco use exceed $300 billion yearly. Tobacco dependence is a significant risk factor for acute and chronic diseases across both the pediatric and adult patient populations [1].
Many educational efforts have helped to heighten knowledge and awareness of tobacco dependence and cessation across the world. The scope of these efforts has substantially varied, and many have had a translational impact. Health communication is at the heart of delivering clear and persuasive messages about quitting tobacco use and can take many forms on both micro and macro levels. Efforts at the local, state, national, and global levels have been made to promote tobacco reduction and cessation across different patient populations. Examples of these efforts include smokefree policies in homes, vehicles, and buildings; price increases in tobacco products; and health education campaigns that target specific groups at higher risk for adverse health effects [2-24]. Some of these campaigns have extended into different sources of media, including mass media and social media platforms.
Social media in our digital era is ubiquitous. Across the trending social media platforms, YouTube is the major one that provides the greatest degree of public video-sharing, thereby making it increasingly easier to find videos as well as extend onto different social media platforms. Unlike Twitter or X that requires more time-intensive mechanisms to locate words across tweets, as well as Facebook and Instagram which may not have as much content publicly available, YouTube itself offers a wealth of data mining with more efficiency which can yield data from the time of its inception. In fact, multiple health-related topics have already received thorough coverage on YouTube including vaccinations, developmental disabilities, skin cancer, and much more [25-27]. For this reason, tapping into YouTube to uncover content that engages viewers is crucial to strengthen the delivery and precision of this communication medium that continues to increase its visibility and prominence in our contemporary digital times. In addition, YouTube is a communication medium that disseminates knowledge and practice on not only health-related topics but also national and global topics trending across the country and world.
Several studies have provided education centered on

tobacco reduction and cessation by publishing videos. Given that YouTube is one of the most prevalent social media platforms at this time [28], this study examined widely viewed YouTube videos related to tobacco cessation. One benefit of YouTube videos is the range of diverse learners who can access information on this medium through narration, closed captioning, and/or visually engaging content at any time anywhere across the globe. Another benefit is how it enables access for people who prefer to learn through video versus print because they cannot or do not want to read.

Notably, there is a paucity of research exploring the impact of YouTube on smoking cessation education, promotion, and resource provision. Among the few studies conducted, most of the videos were more than a decade old. As the basis of informing the direction of this present research, it is crucial to extend the current literature on smoking cessation coverage via YouTube by critically assessing content across videos published over the past decade. The goals of the present study are the following: 1) Describe sources, formats, and content of the widely viewed YouTube videos on smoking cessation; and 2) present implications and recommendations for future research and practice.

Methods

The research design was cross-sectional and involved collecting observational data at one conceptual point in time from the YouTube social media platform. In August to September 2023, the browser history on the computers of the researchers was cleared. Next, with a clean history on the computer, the researchers conducted a search on YouTube using a specific string of key words. Piloting various key words (smoke-free, quit smoking, stop smoking) was helpful in determining which phrase(s) yielded the most relevant videos, highest view counts across videos, and greatest cumulative views for the top 30, 60, and 100 videos, respectively. The key words that formed the search strategy were "stop quit smoking" which ultimately yielded the most widely viewed videos that were directly relevant to smoking cessation. The results were sorted by view count, and the URLs for the 100 most widely viewed videos were copied and saved in a separate file. Overlapping URLs were deleted and replaced. Only one URL for each video was kept for coding.

The researchers then created a codebook based on a review of literature and guidelines from authoritative agencies such as the U.S. Public Health Service and the World Health Organization (WHO). The researcher viewed and coded all videos during August and September 2023. Inter- and intra-rater reliability of the coding was demonstrated. The following information was coded for each video: (a) source of upload, (b) format, (c) number of views, (d) length (in minutes), (e) year of upload, and (f) content.

Eligibility criteria

One inclusion criterion was that the videos be in English. Videos that did not have English narration or written content were excluded from analysis. A second criterion was that the video center on smoking cessation. Each researcher viewed the full video, which constituted the unit of analysis. Music videos not centered on smoking cessation were excluded. No requirements were specified based on length of time.

Measurements and coding specifications

The instrument included the following basic information: coder, video identification number (which was assigned), date the video was uploaded, date the video was coded, length of video (in minutes), number of views, and title of the video. Following this general information, the instrument comprised the following three sections: (a) source of upload, (b) format, and (c) content. Content included many variables (discussed below), all of which were coded dichotomously (*i.e.*, either yes or no) to indicate presence or absence in the respective video.

The source of upload for each video was coded into one of the following four categories: organizational, consumer, governmental, and other sources. The categories for coding Format included Documentary; Interview; Demonstration/ Experiment; Talk by Professional; TV Talk Show/Discussion panel; Animation; Still images; News report with anchor; V-blog; Advertisement; Testimonial/Story; Multiple formats; and "Other formats." The content categories were formulated based on guidelines, recommendations, or related anticipatory guidance from the U.S. Department of Health and Human Services, CDC, WHO, and Healthy People 2030. A total of 11 content categories was created in this codebook: (a) aesthetic effects; (b) health effects; (c) environmental tobacco exposure; (d) stressors/triggers that encompass intrinsic psychological factors; (e) tips, strategies, and resources to quit; (f) outcomes; (g) ingredients in tobacco products; (h) kinds of tobacco products; (i) health benefits of quitting; (j) social/environmental benefits of quitting; and (k) open-ended comments on misinformation or disinformation conveyed in the video. Conceptualization of the codebook involved developing these content categories to account for the depth and breadth of targets for intervention from smoking cessation efforts.

Demonstration of intra- and inter-rater reliability

The researchers demonstrated the intra- and inter-rater reliability of the data regarding coding of the presence of content in the videos. To demonstrate intra-rater reliability, each researcher randomly selected 10 videos and recoded them within 2 weeks of the original coding. All of the dichotomously coded (Yes versus No) content variables in the instrument were included in this analysis. Intra-rater reliability was found to be high (Kappa = 0.942). Inter-rater reliability was demonstrated as well. Five videos were randomly selected from the 100 in the sample, and Inter-rater agreement was also found to be high (Kappa = 0.931).

Statistical analysis

The analysis required calculating descriptive statistics for the different variables under study. Data describing the characteristics of videos were summarized by calculating frequencies and percentages regarding source, format, number of views, length, and content. For each content category, the number of videos that covered the content was identified, and then the number of collective views from those videos covering each particular content area was determined. In addition, the proportion of total cumulative views was determined by dividing the number of views received by the particular videos covering each content area by the total cumulative views received by all videos (N = 334,299,907 views). This analysis was conducted for all content categories specified in the codebook.

Results

The total number of views for the sample of the 100 most widely viewed videos was 334,299,907. The view counts ranged from 205,772 to 44,286,440. These widely viewed videos were posted between 2006 to 2023. Length of videos ranged from 0.25 minutes to 541.42 minutes. The median length of the widely viewed videos was 5.17 minutes. The interquartile range for the sample ranged from 2.52 minutes to 11.40 minutes.

The majority of the widely viewed videos were uploaded by nongovernmental/organizational sources (n = 35), which garnered over 80 million views representing approximately 25% of the cumulative views (Tab. I). Although fewer videos (n = 25) were published by consumer sources, these videos comprised greater than 35% of the cumulative views (greater than 125 million views). 29 videos were uploaded by other sources including talk shows, TV shows, radio shows, or news shows, which garnered less than 30% of cumulative views (~87 million views). 11 videos were uploaded by governmental sources; collectively, these eleven videos accounted for less than 12% of cumulative views (nearly 37 million views).

There was substantial variation in the formats of the widely viewed videos on smoking cessation (Tab. II). The greatest number of videos were in the form of testimonials, generating greater than 77 million views (~20% of the cumulative views). Although animation was covered in fewer videos (n = 23), these videos culminated in nearly 90 million views, accounting for 27% of the cumulative views. Other popular formats included talk by professional (n = 20) which yielded greater than 42 million views, representing nearly 13% of the cumulative views. 14 videos were in other nontraditional formats and garnered ~20 million views (approximately 6% of the cumulative views). Although still images were also covered in a comparable number of videos (n = 13), these videos generated nearly 37 million views (~11% of the cumulative views). Notably although demonstrations/ experiments were depicted in solely eleven videos, they collectively garnered greater than 112 million views, representing almost 34% of the cumulative views. 8 videos were in the form of v-blogs and accounted for ~40 million views (about 13% of the cumulative views). In addition, although seven videos included content on TV talk shows and discussion panels, these videos yielded greater than 27 million views, comprising approximately 8% of the cumulative views. Other formats (news report with anchor, more than two combined formats, interviews and documentaries) accounted for fewer than 24 million views collectively and about 7% of the cumulative views. Advertisements were not covered in any of the widely viewed videos on smoking cessation.

A total of 10 aesthetic effects were coded for each of the 100 widely viewed videos. These 10 aesthetic effects were mentioned in 3 videos for nails and stains up to as many as 14 videos for the aesthetic effect of smell (garnering over 45 million views). In addition to smell, aesthetic effects of smoking that were covered in more videos included effects on taste (13 videos garnering nearly 50 million views), skin (12 videos garnering over 28 million views), teeth (8 videos garnering over 40 million views), hair (8 videos garnering approximately 20 million views), and wrinkles (7 videos garnering ~25 million views). Notably although 7 videos also included

Tab. I. Frequencies, view counts, and cumulative view count percent of widely viewed smoking cessation videos by upload source.

Classification of the source of video upload	N	View count	Cumulative view count percent (%)
Nongovernmental/ organizational	35	83,632,718	25.02
Consumer	25	125,584,143	37.57
Other	29	87,481,657	26.17
Governmental	11	37,601,389	11.25

Tab. II. Frequencies, view counts, and cumulative view count percent of widely viewed smoking cessation videos by format.

Format	N	View count	Cumulative view count percent (%)
Testimonial	32	77,871,704	23.29
Animation	23	90,285,821	27
Talk by professional	20	42,569,819	12.73
Other formats	14	20,346,984	6.09
Still images	13	36,866,284	11.03
Demonstration/ experiment	11	112,671,550	33.7
V-blog	8	43,036,794	12.87
TV talk show/ discussion panel	7	27,437,728	8.21
News report with anchor	5	9,014,217	2.7
Multiple formats	4	6,081,661	1.82
Interview	4	2,690,753	0.8
Documentary	2	5,662,144	1.69
Advertisement	0	0	0

[1] More than one response is possible across videos.

Tab. III. Frequencies, View Counts, and Cumulative View Count Percent of Widely Viewed Smoking Cessation Videos by Health Effects

Health Effects	N	View count	Cumulative view count percent (%)
Illness/mortality	53	213,153,640	63.76
Signs and symptoms	37	156,127,114	46.7
Healthcare utilization	14	27,663,708	8.28
Reproductive effects	4	19,421,021	5.81
Use of durable medical equipment	3	22,070,434	6.6
Health effects on infants	3	2,209,693	0.66

[1] More than one response is possible across videos.

content on breath, these videos yielded fewer than 6 million views. In contrast, a smaller number of videos presented content on voice (n = 4) which garnered substantially more views (nearly 24 million views and ~7% of the cumulative views). Nails and stains were each integrated in 3 videos each, collectively accounting for approximately 20 million views and 6% of the cumulative views.

6 health effects were examined to determine the extent to which they were covered in the sample of widely viewed videos (Tab. III). Illness and mortality were depicted in 53 videos, generating greater than 200 million views (~64% of the cumulative views). Signs and symptoms were integrated in 37 videos, garnering ~156 million views (~47% of the cumulative views). Healthcare utilization was covered in 14 videos, accounting for more than 27 million views (~8% of the cumulative views). 4 videos covered reproductive effects, representing 19 million views and about 6% of the cumulative views. Although 3 videos included content on durable medical equipment, these videos populated greater than 22 million views and about 7% of the cumulative views. Lastly, 3 videos presented content surrounding health effects on infants, generating greater than 2 million views and less than 1% of the cumulative views.

3 levels of environmental tobacco exposure were coded in each of the videos-namely, firsthand, secondhand, and thirdhand smoke. The vast majority of the 100 widely viewed YouTube videos covered content on firsthand smoke exposure (n = 85), which attracted over 300 million views (~90% of total cumulative views). In contrast, coverage of secondhand and thirdhand smoke exposure was significantly scant across videos, with only 9 videos mentioning secondhand smoke (garnering under 19 million views representing ~6% of total cumulative views); and only 1 video referencing thirdhand smoke exposure (attracting under 1 million views and less than one-half of 1% of the total cumulative views).

11 stressors/triggers were included in the codebook for this study; however, 8 were not mentioned in a single video. The only Stressor/Trigger that was mentioned in a substantial portion of the videos (15 of 100) involved peer influence. These videos attracted ~30 million views (~9% of total cumulative views). Poor coping skills were covered in 8 of the videos, generating ~8 million views and less than 3% of the cumulative views. Coverage of mood and anxiety disorders was included in 6 of the

Tab. IV. Frequencies, view counts, and cumulative view count percent of widely viewed smoking cessation videos by tips, strategies, and resources to quit.

Health benefits	N	View count	Cumulative view count percent (%)
Exercise	28	59,700,689	17.86
Testimonials/success stories	24	39,056,885	11.68
Curb cravings	22	30,627,398	9.16
Quitting cold turkey	18	38,664,398	11.57
Support networks	15	50,748,458	15.18
Nicotine patches	15	30,896,422	9.24
Nicotine gum	14	30,267,576	9.05
Hypnosis	14	19,199,356	5.74
Identifying alternatives to mediate triggers	13	12,400,618	3.71
Distraction	9	23,192,581	6.94
Quitline	9	22,922,508	6.86
Individual counseling	8	33,435,289	10
Mindfulness	8	26,586,373	7.95
Nicotine spray	8	24,789,142	7.42
Nicotine lozenges	7	24,238,056	7.25
Prescription medications	7	6,622,004	1.98
Vaping/e-cigarettes for quitting or as harm reduction strategy	6	50,713,216	15.17
Stay busy/active	6	7,503,331	2.24
Tobacco treatment clinic	6	2,731,587	0.82
Quitting incrementally/ gradually through a weaning process	5	29,797,158	8.91
Yoga/meditation	5	6,403,873	1.92
Quit date	5	2,418,442	0.72
Deep breathing	4	10,023,721	3
Chewing	4	7,146,512	2.14
Preparation/planning	4	4,703,425	1.41
Cognitive behavioral therapy	3	23,221,189	6.95
Acupuncture	3	5,604,541	1.68
Contemplation	3	4,526,276	1.35
Laser therapy	2	5,286,922	1.58
Action	2	4,111,724	1.23
Coloring/drawing	2	1,231,189	0.37
Support groups	1	17,211,328	5.15
Intergenerational	1	5,692,242	1.7
One or more of the 5as	1	3,570,242	1.07
Lollipop	1	1,716,680	0.51
Music	1	1,002,950	0.3
Massage	1	1,002,950	0.3
Wellness coach	1	1,002,950	0.3
Change in environment	1	274,082	0.08
Inspirational text messages	0	0	0
Prayer	0	0	0
Group counseling	0	0	0
Motivational interviewing	0	0	0

[1] More than one response is possible across videos.

videos attracting over 26 million views (8% of total cumulative views). Stressful job was mentioned in 1 video, comprising ~2 million views (less than 1% of the total cumulative views).

There were 43 distinct tips, strategies and resources coded in this study (Tab. IV). The one covered in the greatest number of videos was exercise, which was mentioned in 28 videos attracting over 59 million views (~18% of cumulative views). Testimonials/success stories were featured in 24 videos, culminating in ~39 million views (about 12% of cumulative views). 22 videos covered content on curbing cravings, yielding greater than 30 million views (~9% of the cumulative views).

18 videos presented content on quitting cold turkey which collectively comprised greater than 38 million views and about 12% of cumulative views. Support networks were included in 15 videos, garnering ~50 million views (approximately 15% of cumulative views). Although nicotine patches were also integrated in a comparative 15 videos, their cumulative views were substantially smaller (~31 million views), accounting for about 9% of the cumulative views. Nicotine gum was depicted in 14 videos, culminating in ~30 million views and comprising approximately 9% of the cumulative views. Although a comparative number of videos (n = 14) presented content on hypnosis, these videos yielded fewer views (~19 million) which represented about 6% of the cumulative views. In addition although a similar number of videos (n = 13) presented content on identifying alternatives to mediate triggers, these videos populated ~12 million views which accounted for around 4% of the cumulative views.

9 of the videos presented content on distraction, comprising ~23 million views and approximately 7% of the cumulative views. Similarly, 9 videos yielded content on quitline as a resource, garnering also a comparative 23 million views which represented also nearly 7% of the cumulative views. Individual counseling was covered in 8 videos, generating nearly 33 million views and 10% of the cumulative views. In addition, a comparative 8 videos included content on mindfulness (garnering greater than 26 million views and 8% of cumulative views). Nicotine sprays were accounted for in 8 videos (representing ~25 million views and approximately 7% of cumulative views). Similarly, nicotine lozenges were present in 7 videos and culminated in nearly 24 million views, also representing around 7% of cumulative videos. 7 videos depicted content on prescription medications, accounting for greater than 6 million views and a miniscule 2% of the cumulative views.

Notably although only 6 videos presented content on vaping/e-cigarettes for quitting or as a harm reduction strategy, these videos culminated in greater than 50 million views, representing nearly 15% of the cumulative views. In contrast, a comparative 6 videos covering content on staying busy and active generated substantially fewer views (less than 8 million), accounting for ~2% of the cumulative views. 6 videos which also comparatively included content on tobacco treatment clinics yielded ~3 million views which represented less than 1% of the cumulative views. Notably although 5 videos depicted content on quitting incrementally/gradually through a weaning process, collectively these videos garnered nearly 30 million views and ~9% of the cumulative views. In addition, yoga/meditation and quit date were each covered in 5 videos, collectively comprising fewer than 10 million views and also less than 3% of cumulative views.

Although 4 videos presented content on deep breathing, these videos garnered ~10 million views, representing 3% of cumulative views. Chewing was also covered in 4 videos, yielding ~7 million views (2% of the cumulative views). Preparation/planning was included in 4 videos, generating ~5 million views (around 1% of cumulative views). In addition, although 3 videos integrated content on cognitive behavioral therapy, these videos populated 23 million views and 7% of the cumulative views. In addition, a comparative 3 videos depicted content on acupuncture; however, these videos garnered substantially fewer views (greater than 5 million views and less than 2% of cumulative views). Similarly, contemplation was portrayed in 3 videos, generating ~5 million views (1% of cumulative views). Lastly, laser therapy, action and color/drawing were collectively presented in 6 videos, yielding ~10 million views and less than 3% of cumulative views.

Notably although 1 video covered content on support groups, this video generated ~17 million views, comprising nearly 5% of cumulative views. Only 1 video also covered intergenerational considerations; however, this video yielded substantially fewer views (greater than 5 million, ~2% of cumulative views). 6 videos collectively integrated content on one or more of the 5As, lollipops, music, massages, wellness coaches, and changes in environment, culminating in fewer than 10 million views and also fewer than 3% of the cumulative views. Of note, none of the videos covered content on inspirational text messages, prayer, group counseling and motivational interviewing.

A total of 87 videos included content on Quit as an outcome. This topic, not surprisingly, was among those most widely covered in the sample and garnered more than 233 million views (nearly 70% of the total views). The rest of the outcomes, Quit Attempt, Relapse, and Setback were covered in fewer videos, and each of these outcomes accounted for approximately 20% of the cumulative views.

6 specific ingredients in tobacco smoke were examined in the study. A total of 41 videos presented content on nicotine yielding greater than 142 million views (almost 43% of cumulative views). 20 videos depicted content on toxic chemicals, culminating in greater than 65 million views (20% of the cumulative views). Fewer videos (n = 14) delineated content on tar, attracting almost 56 million views which represented ~17% of total views. 6 videos depicted content specifically on carcinogens, generating more than 5 million views (2% of cumulative views). Three videos presented content on household chemicals, accounting for almost 2 million views (less than 1% of total views). Lastly, 3 videos included coverage of

Tab. V. Frequencies, view counts, and cumulative view count percent of widely viewed smoking cessation videos by tobacco products.

Tobacco products	N	View count	Cumulative view count percent (%)
Cigarettes	68	245,631,989	73.48
Marijuana/weed	18	39,103,603	11.67
Vape products	18	75,958,304	22.72
Smokeless tobacco	2	2,904,527	0.87
Cigars	2	2,786,450	0.83

[1] More than one response is possible across videos.

vaping flavors, garnering nearly 2% of cumulative views (~7 million views).

5 specific tobacco products were examined in the study (Tab. V). There were 68 videos, attracting almost 245 million views (> 73% of total views) that provided coverage of cigarettes. Although vape products were only covered in 18 of the videos, these videos accounted for nearly 76 million views, which comprised almost 23% of the cumulative views. A comparative number of videos (n = 18) delineated content on marijuana/weed, which accounted for nearly 39 million views and approximately 12% of cumulative views. Fewer than 5 videos covered content on cigars, smokeless tobacco, and other kinds of products, which generated less than 2% of cumulative views.

9 health benefits of smoking cessation were examined. There were 37 videos that presented content on healthy lifestyle, garnering nearly 72 million views (~22% of the cumulative views). Comparatively, there were 33 videos that depicted content on improved quality of life, yielding approximately 66 million views (about 20% of the cumulative views). 26 videos included content on reduced risk of chronic disease, culminating in ~87 million views (26% of the cumulative views). 16 videos integrated content on breathing easier, accounting for nearly 22 million views and ~6% of the cumulative views. Increased life expectancy was covered in 14 videos, generating ~36 million views and 11% of the cumulative views. Lastly, 10 videos portrayed content on activities of daily living which garnered greater than 20 million views (~6% of the cumulative views). Increased cognition/intellect was covered in 7 videos, populating ~13 million views (almost 4% of the cumulative views). Reduced risk of chronic disease was comparatively included in 7 videos which yielded ~7 million views (about 2% of the cumulative views). Lastly, fertility received scant coverage across the widely viewed videos, accounting for nearly 1 million views (less than 1% of the cumulative views).

In general, the 8 social/environmental benefits of smoking cessation did not attract a large proportion of total views. There was a wide dispersion across social and environmental benefits. 24 videos presented content on optimizing fitness and exercise, accounting for nearly 33 million views (10% of the cumulative views). Increased finances were covered in 18 videos, generating almost 43 million views (~13% of cumulative views). 17 videos depicted content on positive coping strategies which yielded nearly 19 million views (about 6% of the cumulative views). 6 videos included content on increased socialization, generating nearly 10 million views (around 3% of the cumulative views). Notably, there was increasingly scarce content covered across the videos on smoke-free and vape-free environmental considerations. Only 2 videos accounted for smoke-free and vape-free buildings and vehicles, garnering fewer than 5 million views and less than 2% of the cumulative views. There was no coverage on smoke-free and vape-free homes as well as reduced risk of children smoking or vaping across the widely viewed videos on smoking cessation. Tables I-V present a breakdown of number of views and cumulative views for sources, formats and content among the widely viewed videos on smoking cessation.

Discussion

This is one of a few studies to assess the sources, formats, and content of widely viewed YouTube videos on tobacco cessation. Tobacco dependence continues to be a significant risk factor in the onset and progression of a range of harmful illnesses. Education for individuals, families, and communities about tobacco cessation care can be instrumental in helping people achieve cessation. In this digital era, the utilization of social media such as YouTube is a promising way to reach large audiences at very low cost. Given the global reach of YouTube, an assessment of who is disseminating different tobacco-related content revealed information that is relevant to public health education for individuals attempting to stop using tobacco as well as for their families.

Comparison with prior studies

The findings on sources of widely viewed videos on health topics are consistent in some ways with prior studies. Videos uploaded by consumers comprised the primary source of the most widely viewed videos [25, 29-34]. High prevalence of consumer sources may suggest that individuals with tobacco dependence or anyone in their networks will likely draw on non-expert sources to obtain guidance on smoking reduction and cessation. In addition, the cumulative views generated by this study (approximately 334 million) were comparatively greater than several of these content analysis studies on YouTube, many of which yielded fewer than 80 million views. This finding suggested that many consumers have some interest, stake, and contribution in mitigating the tobacco epidemic in one or more ways, potentially from either being closely affected or more distally affected by it. Furthermore, this finding is line with additional prior studies that garnered greater than 300 million views and involved topics that also pertained to individualized health needs (*e.g.*, weight loss, DNA testing) [31, 35].

A significant difference between the present study and these past studies pertains to accounting for environmental tobacco exposure in the coding instrument. In this study,

content categories on environmental tobacco exposure – along with variables pertaining to social engineering, smoke-free homes, vehicles, and buildings – were included in the coding instrument. In the prior studies, environmental tobacco exposure was not accounted for in the coding of content.

Consistency with Official Governmental Guidelines

Across the most widely viewed videos on smoking cessation, a range of content was covered, including strategies and resources to support individuals with tobacco dependence in their efforts to quit. Notably, two of the clinical modalities, the 5As Model and Motivational Interviewing supported by the U.S. Public Service Tobacco Treatment Clinical Guidelines [36], received minimal coverage. Both models are supposed to be implemented through clinical interventions delivered by healthcare professionals. Additional resources recommended such as Nicotine Replacement Therapy products were covered to a much greater extent and included in some of the videos by non-expert sources or healthcare providers with their own video channels. Given evidence of their efficacy, there is a need to include information about these topics in YouTube videos.

An issue identified in the findings that warrants attention is that some widely viewed videos convey information about cessation strategies that are not recommended by official agencies such as the CDC or U.S. Public Health Service. Almost 9% of the videos covered content on curbing cravings, while 4% included content on alternatives to mediate triggers; these are apparently relevant and engaging for different segments of the consumer population. Other topics such as hypnosis and mindfulness received coverage across the widely viewed videos, but neither is supported by the U.S. Public Health Service as efficacious tobacco treatment interventions in the clinical guidelines. These approaches have demonstrated some promising success in supporting patients in achieving tobacco cessation [37-39], but the data are not yet sufficiently compelling for them to be included as part of the Clinical Guidelines. Thus, it is crucial for the government to examine the existing tobacco cessation Clinical Guidelines critically in order to account for content that matches patient preference, acceptability, affordability, and accessibility.

Vaping as a harm reduction strategy

Several of the widely viewed videos covered vaping as a strategy for tobacco reduction and cessation. In light of the growing vaping epidemic, controversy surrounding vaping as a harm-reduction strategy persists [40-42]. It should be noted that while the researcher considers vaping a flawed approach to smoking cessation, many would not consider this misinformation. Of note, the vaping epidemic emerged nearly 5 to 10 years ago. There are still many unknowns about the long-term health effects (beyond EVALI) of vaping, given insufficient knowledge about possible long-term toxicity. One argument in favor of vaping is that, compared with burning tobacco, it does not have the equivalent impact on vapers and their surroundings [43,44]. Nevertheless, the U.S. Public Health Service does not recommend vaping in its tobacco treatment guidelines. As more knowledge is disseminated over time about the impact of vaping on human health, it is possible that perceptions pertaining to its efficacy as a harm-reduction strategy for many could change.

Environmental tobacco exposure

One of the most important findings from this study related to what was not found in the widely viewed videos. Hardly any videos covered content on secondhand and thirdhand smoke exposure, both forms of environmental tobacco exposure that significantly impact nonsmokers [45]. In addition, none of the videos presented content on supporting tobacco-free homes, vehicles, and buildings along with social engineering, all of which also contribute significantly to reducing environmental tobacco exposure for smokers and nonsmokers [46-50]. Tobacco exposure is one of the leading environmental exposures for a host of acute and chronic diseases [50, 51]. Oftentimes, coverage of content on social media matches trends in communities across both national and global levels. This finding suggested that since tobacco exposure was not widely covered in social media, it is possible that it also does not receive coverage in other publicly visible modalities (*e.g.*, outdoor advertisements, billboards, print materials). It follows that integrating content that addresses tobacco exposure in prominent social media could lay the foundation for addressing more seriously this leading environmental exposure as a significant health hazard for both smokers and nonsmokers. Furthermore, viewers who are smokers accessing this content could gain insight into the impact of their smoking on those around them. This gap in coverage warrants further research to find ways to integrate this content into education, especially for specialized populations such as children, pregnant women, and nonsmokers. Greater attention to environmental tobacco smoke may benefit smokers as well by heightening their awareness of how their tobacco use has harmful consequences not only for themselves but for others in their family and community.

Implications for improving access to tobacco cessation resources

The findings revealed a wealth of self-help tips and strategies to support individuals with tobacco dependence, along with their social, familial, and professional networks. Since these videos are reaching so many people, they may have the potential to help those who are not interested or able to seek cessation care in healthcare and community settings. While the ease of accessing these videos on their own terms and time is a significant benefit, it should also be recognized that the efficacy of social media platforms such as YouTube has not been established as an evidence-based practice in mitigating tobacco dependence on individual and population levels.

Nevertheless, some of the videos included evidence-based guidelines (*e.g.*, from the U.S. Public Health Service's Treating Tobacco Use and Dependence Clinical Practice Guidelines), and it is reasonable to expect that increasing awareness of such guidance can mitigate the global tobacco epidemic. Establishing credibility in cessation messaging could also contribute to the larger goal of the WHO in creating the next tobacco-free generation worldwide, the goals of Healthy People 2030 on a national level, and the United Nations Sustainable Development Goals on a global level.

Implications for health and regulatory policies

Tobacco control recommendations by the WHO, U.S. Public Health Service, Healthy People 2030, and United Nations Sustainable Development Goals have the potential to inform legislation, taxation, and social engineering. Findings from the WHO's MPOWER report revealed that 23 countries (Seychelles, Mauritius, Costa Rica, Brazil, Panama, Surinam, Colombia, Canada, Uruguay, Argentina, United Kingdom, Turkey, Portugal, Russia, Ireland, Romania, Estonia, Denmark, Spain, Norway, Iran, Australia, and New Zealand) obtained the highest scores for the implementation and enforcement of their tobacco control policies and legislation, including smoke-free regulations, advertising bans, taxation, and uptake in the visibility of health warnings on cigarette packages [52]. Integrating this content into the widely viewed videos can align and promote contemporary policies intended to promote smoke-free environments across the world.

In addition, integrating increased smoke-free environment content into videos could also benefit two specialized populations, infants and pregnant women. After the enactment of smoke-free legislation in Brazil, the average infant mortality rate declined substantially from 24.5 to 13.0 deaths per 1,000 live births from 2000 to 2016, and the neonatal mortality rate declined from 15.6 to 9.0 deaths per 1000 live births [53]. While these declines may not be entirely attributable to the enactment of smoke-free legislation, it is likely that such legislation made a meaningful contribution to saving lives. In Norway, ever since tobacco prohibition was implemented across restaurants, public transport, schools, healthcare institutions, and all public office spaces in 2004, the prevalence of smoking in pregnancy decreased significantly from 26% in 1999 to nearly 2% in 2021 [54]. It follows, then, that integration of these tobacco control measures into videos on social media can translate to normalizing such social customs and addressing environmental tobacco exposure more comprehensively for children and pregnant women as well as the global population of smokers and nonsmokers. It is important to note that the U.S. Public Health Service is responsible for protecting the public health of citizens across the country; this agency created the Tobacco Treatment Clinical Practice Guidelines, which presented recommendations to address tobacco use and exposure as the single most preventable leading cause of death. While creating policies and guidelines is important, they will not confer maximum benefits to the public unless they are implemented. Review of the most widely viewed YouTube videos posted over the past 16 years suggested that the government has not sufficiently succeeded in creating communications about their guidelines that engage consumers. In turn, this may limit the extent to which the public is aware and supportive of such guidelines. Part of this disconnect could pertain to the content covered, which may not be perceived as directly relevant to the audience's preferences and acceptable for health behavior change. In short, this content may not spark engagement for this lay audience and fails to appeal to them.

Expanding the reach of tobacco cessation campaigns

Only four videos among all the widely viewed ones on smoking cessation accounted for content pertaining to a tobacco cessation campaign. In fact, the deliverer of these videos was the only source originating from a campaign. In these videos, the TIPS campaign spearheaded by the CDC featured testimonials from survivors of tobacco-related illnesses. Other campaigns are not directly centered on promoting reduction and cessation (*e.g.*, Safe-to Sleep and American Cancer Society campaigns); however, components of these campaigns can involve delivery of information surrounding tobacco use and support of cessation. The Safe-to-Sleep campaign in particular follows recommendations by the American Academy of Pediatrics to optimize safe sleep conditions for infants. One of these recommendations is to encourage all caregivers of infants to reduce environmental tobacco exposure for infants. Further, as part of this campaign, tobacco use and exposure are environmental and behavioral determinants that are targets for intervention, both prenatally (reduce or stop tobacco use during pregnancy) and postnatally (stop tobacco use and, in turn, reduce or eliminate environmental tobacco exposure for infants); this can reduce the risk of Sudden Infant Death Syndrome (SIDS), which is a leading cause of infant mortality.

Tobacco use and exposure are causal factors that adversely impact response to treatment for many kinds of cancer and can increase both morbidity and mortality for cancer patients. Cessation of tobacco use and reduction of environmental tobacco exposure are targets in a variety of cancer prevention and control campaigns. Future content on YouTube could provide more coverage of tobacco-related content across these campaigns, which could increase their visibility. As previously mentioned, much of the content found in one social media platform can be disseminated to others. Given that YouTube continues to be the most popular public video-sharing platform, publishing messages on YouTube can extend onto different social media platforms as well.

Recommendations for further research

As tobacco continues to be a leading cause of environmental exposure, it is crucial to find ways to

increase awareness and interest among consumers to address this problem. Additional research is needed to improve understanding about ways to incorporate this topic into videos that will engage consumers. Given the scant coverage of environmental tobacco exposure as well as firsthand smoke exposure for specialized populations, additional research is needed to increase awareness of how and why environmental tobacco smoke exposure has particularly harmful effects on certain people. Future study designs involving non-evidence-based practices for tobacco cessation could account for prospective and longitudinal studies as the basis to assess the efficacy of these interventions over timespans, settings, and patient populations. Consistency in findings that support the efficacy of these non-evidenced-based practices over time could increase consideration of their inclusion into existing evidence-based practices on tobacco cessation. Given that viewers have the opportunity to post comments for YouTube videos and since there were many comments across the videos in this sample, a closer examination of the comments could yield insights into consumers' reactions to different topics or formats in the videos. A thematic analysis of the comments might also yield information related to viewer engagement, perspectives on content, and acceptance of content.

Limitations

This study was limited in several important ways that must be considered when interpreting the results and conclusions. First, the design was cross-sectional, which limits generalizability over time. This is particularly important because the nature of the videos on YouTube and the views they attract are changing constantly. A second limitation was related to the sample. While the videos were selected using a cleared browsing history, the algorithm that generated the resulting sample is not known. It is possible that some widely viewed videos were not included. Delimiting the scope to videos in English further limits generalizability, which is important since smoking rates are high in many parts of the globe where English is not the dominant language. Also, the sample size of 100 videos was arbitrary. A third limitation is related to the nature of the data themselves. The main outcome in this study was number of views, as based on the premise that reach is an important way to assess health communications. However, there was no way to distinguish between number of views versus number of viewers. Another issue was that the results regarding content coverage were disproportionately influenced by a comparatively small number of videos that attracted a comparatively large proportion of views. A fourth limitation pertained to the limitations of the search strategy. It is possible that substantially fewer videos among the widely viewed covered environmental tobacco exposure (*e.g.*, secondhand smoke, thirdhand smoke, social engineering, smokefree, *etc.*), given the inherent nature of the search strategy. Despite these limitations, the findings are significant for several reasons. The videos in this study received over 334 million views, suggesting that people are searching YouTube to learn about ways to stop smoking. Given this wide reach, descriptions of information that are and are not being conveyed are vital for public health education.

Conclusions

Tobacco dependence continues to be a significant risk factor in the onset and progression of a range of harmful illnesses. Education for individuals, families, and communities about tobacco cessation care can be instrumental in helping people achieve cessation. In this digital era, the utilization of social media such as YouTube is a promising way to reach large audiences at very low cost. Given the global reach of YouTube, an assessment of who is disseminating different tobacco-related content revealed information that is relevant to public health education for individuals attempting to stop using tobacco as well as for their families. This study produced several findings that have implications for improving public health. Videos posted by nongovernmental/organizational sources attracted the largest number of views. Some of the content in these videos was not in line with evidence-based practices for tobacco treatment established by governmental guidelines. Nevertheless, public health educators need to learn from a variety of sources how to create videos that are engaging. Videos currently posted by governmental agencies are not sufficiently appealing to consumers. Finding ways to deliver content that is not only up-to-date and accurate but also engaging, appealing, and relevant to diverse specialized populations affected by tobacco use and exposure can align and achieve the goals of reducing the public health burden caused by tobacco use and environmental exposure.

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Conflict of interest statement

The authors declare that they have no conflicts of interest.

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with human

participants or animals performed by any of the authors.

Authors' contributions

AJ: conceptualization. AJ: data curation. AJ: formal analysis. AJ, AH: Investigation. AJ: methodology. AJ: writing original draft. AJ, AH: writing review & editing.

References

[1] U.S. Department of Health and Human Services. The health consequences of smoking: 50 years of progress. A Report of the Surgeon General. U. S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health 2014.

[2] International Agency for Research on Cancer (IARC). IARC handbooks of cancer prevention, tobacco control, 13: Evaluating the effectiveness of smoke-free policies. WHO 2009.

[3] Mackay DF, Irfan MO, Haw S, Pell JP. Meta-analysis of the effect of comprehensive smoke-free legislation on acute coronary events. Heart 2010;96:1525-30. https://doi.org/10.1136/hrt.2010.199026.

[4] Bauer JE, Hyland A, Li Q, Steger C, Cummings KM. A longitudinal assessment of the impact of smoke-free worksite policies on tobacco use. Am J Public Health 2005;95:1024-29. https://doi.org/10.2105/AJPH.2004.048678.

[5] Borland R, Owen N, Hocking B. Changes in smoking behaviour after a total workplace smoking ban. Aust J Public Health 1991;15:130-4. https://doi.org/10.1111/j.1753-6405.1991.tb00322.x.

[6] Chapman S, Borland R, Scollo M, Brownson RC, Dominello A, Woodward S. The impact of smoke-free workplaces on declining cigarette consumption in Australia and the United States. Am J Public Health 1999;89:1018-23. https://doi.org/10.2105/ajph.89.7.1018.

[7] Evans WN, Farrelly MC, Montgomery E. Do workplace smoking bans reduce smoking? Am Econ Rev 1999;89:728-47. https://doi.org/10.1257/aer.89.4.728.

[8] Farrelly MC, Evans WN, Sfekas AE. The impact of workplace smoking bans: Results from a national survey. Tob Control 1999.8:272-77. https://doi.org/10.1136/tc.8.3.272.

[9] Heloma A, Jaakkola MS, Kahkonen E, Reijula K. The short-term impact of national smoke-free workplace legislation on passive smoking and tobacco use. Am J Public Health 2001;91:1416-8. https://doi.org/10.2105/ajph.91.9.1416.

[10] Longo DR, Johnson JC, Kruse RL, Brownson RC, Hewett JE. A prospective investigation of the impact of smoking bans on tobacco cessation and relapse. Tob Control 2001;10:267-72. https://doi.org/10.1136/tc.10.3.267.

[11] Moskowitz JM, Lin Z, Hudes ES. The impact of workplace smoking ordinances in California on smoking cessation. Am J Public Health 2000;90:757-61. https://doi.org/10.2105/ajph.90.5.757.

[12] Task Force on Community Preventive Services. Recommendations regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke. Am J Prev Med 2001;20(2 Suppl):10-5.

[13] Farkas AJ, Gilpin EA, White MM, Pierce JP. Association between household and workplace smoking restrictions and adolescent smoking. J Am Med Assoc 2000;284:717-22. doi:10.1001/jama.284.6.717.

[14] American Lung Association. Smokefree air laws. Available at: https://www.lung.org/policy-advocacy/tobacco/smokefree-environments/smokefree-air-laws (Accessed on: 25/11/2023).

[15] American Lung Association. Youth vaping prevention: Get your head out of the cloud. Available at: https://www.lung.org/quit-smoking/end-youth-vaping (Accessed on: 25/11/2023).

[16] American Nonsmokers' Rights Foundation. Number of smoke-free and other tobacco-related laws. Available at: https://no-smoke.org/ (Accessed on: 25/11/2023).

[17] Wechsler L, Rigotti N. Cigarette use by college students in smoke-free housing – Results of a National Study. Am J Prev Med 2001;20:202-7. https://doi.org/10.1016/s0749-3797(00)00313-5.

[18] Centers for Disease Control and Prevention (CDC) - 2022. Tips from former smokers. Available at: https://www.cdc.gov/tobacco/campaign/tips/index.html (Accessed on: 25/11/2023).

[19] U. S. Food and Drug Administration. Every Try Counts campaign. Available at: https://www.fda.gov/ TobaccoProducts/PublicHealthEducation/PublicEducationCampaigns/EveryTryCounts Campaign/default.htm (Accessed on: 25/11/2023).

[20] U.S. Food & Drug Administration. FDA launches new campaign: "The Real Cost" youth e-cigarette prevention campaign. Available at: https://www.fda.gov/tobacco-products/public-health-education-campaigns/real-cost-campaign (Accessed on: 25/11/2023).

[21] Truth Initiative. Why tobacco is a racial justice issue. Available at: https://truthinitiative.org/ research-resources/targeted-communities/why-tobacco-racial-justice-issue (Accessed on: 25/11/2023).

[22] NYC Health-Smoking Number-NYC Health. Health department launches new anti-smoking media campaign featuring Commissioner Bassett and her quit smoking "number." City of New York. Available at: https://www.acsh.org/news/2018/02/26/nyc-health-department-launches-new-anti-smoking-campaign-12625 (Accessed on: 25/11/2023).

[23] National Cancer Institute. The Role of the Media in Promoting and Reducing Tobacco Use. Tobacco Control Monograph No. 19. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. NIH Pub. No. 07-6242; 2008.

[24] Callinan JE, Clarke A, Doherty K, Kelleher C. Legislative smoking bans for reducing secondhand smoke exposure, smoking prevalence and tobacco consumption. Cochrane Database Syst Rev 2010;2:CD005992. https://doi.org/10.1002/14651858.

[25] Basch CH, Basch CE, Hillyer GC, Reeves R. YouTube videos related to skin cancer: A missed opportunity for cancer prevention and control. JMIR Cancer 2015;1:e1. https://doi.org/10.2196/cancer.4204.

[26] Basch CH, Zybert P, Reeves R, Basch CE. What do popular YouTubeTM videos say about vaccines? Child Care Health Dev 2017;43:499-503. https://doi.org/10.1111/cch.12442.

[27] Kollia B, Kamowski-Shakibai MT, Basch CH, Clark A. Sources and content of popular online videos about autism spectrum disorders. Health Promot Perspect 2017;7:238-44. https://doi.org/10.15171/hpp.2017.41.

[28] Pew Research Center. Social media use in 2021. Available at: https://www.pewresearch.org/internet/2021/04/07/social-media-use-in-2021/ (Accessed on: 25/11/2023).

[29] Al-Busaidi IS, Anderson TJ, Alamri Y. Qualitative analysis of Parkinson's disease information on social media: the case of YouTube™. EPMA Journal 2017;8:273-7. https://doi.org/10.1007/s13167-017-0113-7.

[30] Basch CH, Ruggles KV, Berdnik A, Basch CE. Characteristics of the most viewed YouTube™ videos related to bullying. Int J Adolesc Med Health 2015;29:/j/ijamh.2017.29.issue-4/ijamh-2015-0063/ijamh-2015-0063.xml. https://doi.org/10.1515/ijamh-2015-0063.

[31] Basch CH, Fung IC, Menafro A, Mo C, Yin J. An exploratory assessment of weight loss videos on YouTube™. Public Health 2017;151:31-8. https://doi.org/10.1016/j.puhe.2017.06.01.

[32] Basch CH, Menafro A, Mongiovi J, Hillyer GC, Basch CE. A content analysis of YouTube™ videos related to prostate cancer. Am J Mens Health 2017;11:154-7. https://doi.org/10.1177/1557988316671459.

[33] MacLean SA, Basch CH, Reeves R, Basch CE. Portrayal of generalized anxiety disorder in YouTube™ videos. Int J Soc Psychiatry 2017;63:792-5. https://doi.org/10.1177/0020764017728967.

[34] Simsek H, Buyuk SK, Cetinkaya E, Tural M, Koseoglu MS. "How I whiten my teeth": YouTube™ as a patient information resource for teeth whitening. BMC Oral Health 2020;20:183. https://doi.org/10.1186/s12903-020-01172-w.

[35] Basch CH, Hillyer GC, Wahrman MZ, Garcia P, Basch CE. DNA testing information on YouTube: Inadequate advice can mislead and harm the public. J Genet Couns 2021;30:785-92. https://doi.org/10.1002/jgc4.1375.

[36] U.S. Preventive Services Taskforce. Interventions for tobacco smoking cessation in adults, including pregnant persons: U.S. Preventive Services Task Force recommendation statement. J Am Med Assoc.2021;325:265-79. https://doi.org/10.1001/jama.2020.25019.

[37] Araujo MS, Silva LGD, Pereira GMA, Pinto, NF, Costa, FM, Moreira, L, Nunes, DP, Canan MGM, Oliveira MHS. Mindfulness-based treatment for smoking cessation: a randomized controlled trial. J Bras Pneumol 2022;47:e20210254. https://doi.org/10.36416/1806-3756/e20210254.

[38] Barré T, Ramier C, Mounir I, Renaud D, Menvielle L, Marcellin F, Carrieri P, Protopopescu C, Cherikh F. Examining the relationships between mindfulness and tobacco craving factors. Subst Use Misuse 2022;57:656-9. https://doi.org/10.1080/10826084.2021.2019782.

[39] Spears CA, Hedeker D, Li L, Wu C, Anderson NK, Houchins SC, Vinci C, Hoover DS, Vidrine JI, Cinciripini PM, Waters AJ, Wetter DW. Mechanisms underlying mindfulness-based addiction treatment versus cognitive behavioral therapy and usual care for smoking cessation. J Consult Clin Psychol 2017;85:1029-40. https://doi.org/10.1037/ccp0000229.

[40] Janmohamed K, Walter N, Sangngam N, Hampsher S, Nyhan K, De Choudhury M, Kumar N. Interventions to mitigate vaping misinformation: a meta-analysis. J Health Commun 2022;27:84-92. https://doi.org/10.1080/10810730.2022.2044941.

[41] Jiang N, Xu S, Li L, El-Shahawy O, Freudenberg N, Shearston JA, Sherman SE. The mediating effect of e-cigarette harm perception in the relationship between e-cigarette advertising exposure and e-cigarette use. Int J Environ Res Public Health 2022;19:6215. https://doi.org/10.3390/ijerph19106215.

[42] Mattingly DT, Agbonlahor O, Rai J, Hart JL, McLeish AC, Walker KL. Harm perceptions of secondhand e-cigarette aerosol among youth in the United States. Addict Behav.2022;137:107535. https://doi.org/10.1016/j.addbeh.2022.107535.

[43] Hajek P, Phillips-Waller A, Przulj D, Pesola F, Myers Smith K, Bisal N, Li J, Parrott S, Sasieni P, Dawkins L, Ross L, Goniewicz M, Wu Q, McRobbie HJ. A randomized trial of E-cigarettes versus nicotine-replacement therapy. N Engl J Med 2019;380:629-37. https://doi.org/10.1056/NEJMoa1808779.

[44] McAlinden KD, Eapen MS, Lu W, Sharma P, Sohal SS. The rise of electronic nicotine delivery systems and the emergence of electronic-cigarette-driven disease. Am J Physiol Lung Cell Mol Physiol 2020;319:L585-95. https://doi.org/10.1152/ajplung.00160.2020.

[45] Torres S, Merino C, Paton B, Correig X, Ramírez N. Biomarkers of exposure to secondhand and thirdhand tobacco smoke: Recent advances and future perspectives. Int J Environ Res Public Health 2018;15:2693. https://doi.org/10.3390/ijerph15122693.

[46] Faber T, Mizani MA, Sheikh A, Mackenbach JP, Reiss IK, Been JV. Investigating the effect of England's smoke-free private vehicle regulation on changes in tobacco smoke exposure and respiratory disease in children: a quasi-experimental study. Lancet Public Health 2019;4: e607-17. https://doi.org/10.1016/S2468-2667(19)30175-6.

[47] Lee BX, Kjaerulf F, Turner S, Cohen L, Donnelly PD, Muggah R, Davis R, Realini A, Kieselbach B, MacGregor LS, Waller I, Gordon R, Moloney-Kitts M, Lee G, Gilligan J. Transforming our world: Implementing the 2030 agenda through sustainable development goal indicators. J Public Health Policy 2016;37(Suppl 1):13-31. https://doi.org/10.1057/s41271-016-0002-7.

[48] Painter K. Outdoor smoking: fair or foul? Br Med J 2019;366:l5754. https://doi.org/10.1136/bmj.l5754.

[49] Radó MK, Mölenberg FJM, Westenberg LEH, Sheikh A, Millett C, Burdorf A, van Lenthe FJ, Been JV. Effect of smoke-free policies in outdoor areas and private places on children's tobacco smoke exposure and respiratory health: a systematic review and meta-analysis. Lancet Public Health 2021;6:e566-78. https://doi.org/10.1016/S2468-2667(21)00097-9.

[50] Sachs JD. From millennium development goals to sustainable development goals. Lancet 2012;379:2206-11. https://doi.org/10.1016/S0140-6736(12)60685-0.

[51] World Health Organization (WHO). (2021). WHO report on the global tobacco epidemic: Addressing new and emerging products. Available at: https://www.who.int/publications (Accessed on: 25/11/ 2023).

[52] Heydari G. Which countries are the best in tobacco control? A quantitative analysis of the MPOWER 2017. J Glob Health Rep 2019;3:e2019039. https://doi.org/10.29392/ joghr.3.e2019039.

[53] Hone T, Szklo AS, Filippidis FT, Laverty AA, Sattamini I, Been JV, Vianna C, Souza M, de Almeida LM, Millett C. Smoke-free legislation and neonatal and infant mortality in Brazil: longitudinal quasi-experimental study. Tob Control 2020;29:312-9. doi:10.1136/tobaccocontrol-2019-054923.

[54] Norwegian Institute of Health. (2022). Available at: https://www.fhi.no/en/ (Accessed on: 25/11/2023).

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HEALTH PROMOTION

Monitoring the utilization and effectiveness of Iron and Vitamin D supplementations program and its predictive factors in high schools' girls in Qom, Iran

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Keywords

Iron deficiency • Supplementation program • Vitamin D • Deficiency • High school • Iran

Summary

Background. *Iron and Vitamin D3 deficiency is one of the major global health problems in teenagers and adolescent population. This study was aimed to monitor the utilization and predictive factors of Iron and Vitamin D Supplementations Program (IVDSP) in high schools' girls.*
Methods. *In a cross sectional study, the pattern of Iron and D3 consumption based on IVDSP on 400 high schools' girl in Qom, Iran assesses. Data collection was used by a reliable and standard researcher based questionnaire and daily, weekly, monthly and seasonally consumption of complementary minerals in schools were gathered. Data analysis conducted using SPSS version 20 (SPSS Inc., Chicago, IL, USA) by chi square, independent t-test and multivariate logistic regression.*
Results. *The mean age of subjects was 15.14 ± 1.52 years and ranged from 12 to 18 years old. The total weekly prevalence of D3 and Iron consumption in high schools' girls was calculated 36.73% and the weekly prevalence of Iron and monthly prevalence of Vitamin D3 consumption was 33.75% and 40.5%, respectively. The most common causes of non-consumption were bad taste 49.31%, Iranian made drug 20.27%, drug sensitivity 19.82% and drug interaction 10.60%, respectively.*
Conclusions. *The inadequate and incomplete rate of IVDSP in Qom was high and more than 60% of distributed supplementations have been wasted. Results showed that students who were participated in educational orientation classes were more successful and eager in Iron and Vitamin D3 consumption. Therefore, more educational explanatory interventions for both students and her parents recommended to increase the efficiency of the program.*

Introduction

Iron and Vitamin D deficiency is one of the major global health problems, which is also common in the adolescent population and can have a negative impact during phases of rapid growth, increasing susceptibility to infection, autoimmune and other chronic disease and also impair mental development and learning [1, 2]. Anemia due to Iron deficiency is a prevalent disorder in high school girls and is defined based on hemoglobin concentration lower than 12 gr/dl in women [3] while the optimum level of Vitamin D is 30 ng/ml [4]. In the absence of adequate level, about 20-25 μg (800-1,000 IU), the oral Vitamin D supplementation is required daily to achieve sufficient levels in adults and children [5]. Current estimates indicate that Vitamin D deficiency (VDD) is a common health problem, affecting 1 billion people globally [6]. Also, more than two billion people suffer from Iron deficiency anemia as the most common nutritional deficiency in the world [7]. According to the estimate of the World Health Organization, 25% of students suffer from Iron deficiency anemia and in developing countries, the prevalence of Iron deficiency anemia in students and adolescents has been reported from 29.9% to 79.6% [8, 9] and it is reported 13.9% in Iranian population with age less than 18 years in a meta-analysis study [10].
The need for Iron during adolescence, which according to the definition of the WHO is between the ages of 10 and 19 years, increases 2 to 3 times due to physiological and physical changes in girls. The prevalence of Iron deficiency anemia in this age group and especially in girls after puberty due to menstrual bleeding and growth spurt is increasing. Therefore, high-risk groups of Iron deficiency anemia are menstruating girls, pregnant women, and the elderly people [11-14]. Lack of micronutrients, including Iron and Vitamin D, has major effects on human health and economic and social development [14]. This shortage can lead to a waste of educational and health care resources, a decrease in productivity due to an increase in maternal mortality and morbidity, and ultimately a decrease in physical and mental capacity in a large part of society [15]. Complementary therapy, supplementation programs, nutrition education, and food fortification

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with Iron compounds are the WHO strategies for control and prevent Iron and Vitamin D deficiency, are [8]. Furthermore, Iron and Vitamin D Supplementation Program (IVDSP) was implemented in all high school' girls during the past 20 years in Iran improve the health of students through nutritional education and supplemental assistance. According to this program, 16 Table ts of Ferfolic and 9 Table ts of Vitamin D3 (50,000) are distributed among students over 12 years of age on a weekly and monthly basis [12]. Despite the reports of several studies that show the positive effect of the supplement program in reducing the level of Vitamin D and Iron deficiency, a national report and some other researches show the lack of correct use of Iron supplements and the high prevalence of anemia and Vitamin D deficiency among Iranian teenagers [16-20]. Therefore, the present study was designed and conducted to monitor the utilization and predictive factors of Iron and Vitamin D Supplementations Program (IVDSP) in high schools' girls.

Materials and methods

In a cross sectional study, 400 girl students in high schools of Qom, Iran recruited to monitor the Iron and D3 Complementary Therapy program in June 2023. Sample size calculation was done by using the type one error, $\alpha = 0.05$, success rate of program in a recent study in Semnan, Iran equal 16.5%, and the precision proportion as $d = 0.04$ based on following formula which use for prevalence estimation studies [21].

The minimum sample size for this study has been calculated 350, but due to clustering sampling method and considering the design effect equal 1.35, overall 486 questionnaires were distributed and finally, data of 400 girls' students were analyzed. We used cluster sampling method to select the high schools from different districts of Qom city and in each district, one high school selected. In the next stage, one class selected randomly and all consent students recruited for study. Verbal informed consent was taken from all participants.

Inclusion criteria was girls who living in Qom and studying in governmental high school. Girls who were studying in high schools without complete distribution of Iron and Vitamin D complementary, girls who were transferred from other high schools during the educational year, and girls who were using foreign complementary drugs were excluded form study.

Data collection was used by a reliable and standard researcher based questionnaire that was used in our recent study [22]. The prepared questionnaire including two different sections. First section contains demographic characteristics such as age, menarche age, nationality, marital status, weight, height, BMI, high school level, educational major, parents' education and parents' job and socioeconomic status. The second section of questionnaire including some questions that evaluate the complementary consumption pattern in high school girls' students. The daily, weekly, monthly and seasonally consumption of complementary in schools including Iron and Vitamin D3 consumption as well as home consumption including folic acid, Calcium, Zinc, Vitamin C, Multi Vitamin, Vitamin B, and Other complementary drugs were gathered. The reliability of used questionnaire of Iron and Vitamin D supplementations program in current study was 0.780 ($\alpha = 0.780$; CI 95%: 746-0.811).

Ethical consideration

All the students were free to participate in this study and verbal informed consent taken from all included subjects. Moreover, the authors were assured all participants that their information will be confidential. In addition, the study protocol was approved by ethical committee of Qom University of Medical Sciences by IR.MUQ.REC.1401.048 at 10.05.2022.

Statistical analysis

The primary outcome in current study was the weekly Iron and Vitamin D3 supplement consumption in high schools. Therefore, girls who have consumed Iron and Vitamin D3 supplement weekly in their schools categorized as consumed and compared with other students. Therefore, monitoring and effectiveness of Iron and Vitamin D supplementations program evaluated by regular and on time of these two supplements.

Statistical analysis conducted using SPSS version 20 (SPSS Inc., Chicago, IL, USA). First, we used descriptive statistics to show the demographic characteristics of subjects and prevalence rate of different supplement consumption. Chi square test was used to assess relationship between supplement consumption and qualitative variables such as contribution in explanatory sessions, and consumption surveillance. Independent t-test was used to evaluate difference of mean and standard deviation of quantitative variables such as age, menarche age, BMI, weight and height between two different groups (consumed and not consumed). P-value lower than 0.05 considered as significant.

Results

In this study we assess 486 students in high schools of Qom, Iran and finally the questionnaires of 400 students received (response rate = 82.30%). The mean age of subjects was 15.14 ± 1.52 years and ranged from 12 to 18 years old. The mean of BMI was 20.44 ± 3.14 kg/m^2 and the mean of weight and height was 52.12 ± 8.62 and 159.66 ± 7.19 cm, respectively. The mean of self-rated health was 7.82 ± 2.13 that varied from 1 to 10 (used 10 Point-Likert scale of self-rated heath) and approximately 10% of high school girls reported the SRH lower moderate (quit weak and weak). More details of demographic variables of participations depicted in Table I.

Tab. I. Descriptive statistics of demographic continues variables of participations in study.

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age, year	400	12.00	18.00	15.14	1.52
Menarche age, year	373	9.00	16.00	12.95	1.25
BMI, kg/m^2	400	12.49	37.28	20.44	3.14
Weight, kg	400	30.00	83.00	52.12	8.62
Height, cm	400	130.00	175.00	159.66	7.19
Self-rated health score	400	1.00	10.00	5.82	2.13

Tab. II. Descriptive statistics of demographic categorical variables of participations in study.

Variables		Frequency	Valid percent
High school level	First high school	221	55.25
	Second high school	179	44.75
Educational major	Experimental	107	26.8
	Human science	47	11.8
	Mathematical	15	3.8
	Technical science	12	3.0
	None	219	54.8
Nationality	Iranian	290	72.5
	Other	110	27.5
Marital	Single	380	95.0
	Married	20	5.0
Mother education	Illiterate	48	12.0
	Elementary	162	40.5
	Diploma	105	26.3
	Bachelor	70	17.5
	MSc & Upper	15	3.8
Father education	Illiterate	27	6.8
	Elementary	151	37.8
	Diploma	126	31.5
	Bachelor	65	16.3
	MSc & Upper	31	7.8
Mother job	Physician/Manager	22	5.5
	Staff	28	7.0
	Housekeeper	316	79.0
	Unemployment/ Free	32	8.0
	Retried	2	.5
Father Job	Physician/Manager	19	4.8
	Staff	72	18.0
	Unemployment/ Free	276	68.9
	Retried	24	6.0
	Died	9	2.3
Socio Economic Status	Low Income	82	20.5
	Lower average income	164	41.0
	Average income	78	19.5
	Upper average income	76	19.0

According to demographic characteristics (Tab. II), 26.8% studying in experimental major and 72.5% were Iranian. Socioeconomic status of participated studies showed that only 21.3% of students' mothers and 24.1% of students' fathers have college academic education and only 12.5% of students' mothers and 22.8% of students' fathers have professional jobs. Finally, 38.5% have average and upper average income in society. From all studied students, 132 (33%) reported a type of background disease including depression (17.5%), hypothyroidism (4.5%) and other diseases (11%).

Our effectiveness results of program execution showed that the prevalence of both D3 and Iron consumption (complementary consumption in high schools) was calculated 36.73% (126 students). The weekly prevalence of Iron and Vitamin D3 consumption was 33.75% and 6.25% and the monthly prevalence for Iron and Vitamin D3 consumption was estimated as 57% and 40.5%, respectively (Tab. III). Our results showed that the most important causes of un-consumption were bad taste (49.31%), Iranian made drugs (20.27), drug sensitivity (19.82%) and drug interaction (10.60%), respectively.

We assessed the relationship between of complementary consumption with demographic variables and the results in Table IV showed that contribution of students in explanatory sessions ($p = 0.003$), contribution of students in school sessions ($p = 0.001$) were predictor variables for better complementary consumption in high schools. However, contribution of girls' parents in sessions and executive of consumption surveillance were not significant variables for complementary consumption in high schools' girls.

Comparing the mean of age, menarche age, BMI, weight and height between two different groups of students in high schools based on complementary consumption (Tab. V) showed that the menarche age in complementary consumption group was statistically significant than other group ($p = 0.043$), but there was not significant difference between two groups regarding to age, BMI, weight and height.

The binary multivariate logistic regression showed that lower age and contribution in explanatory sessions for supplementary consumption were the most positive important predictors of IVDSP success. Based on our results age (AOR = 0.732, CI95%: 0606-0883, $p = 0.001$) and contribution in explanatory sessions (AOR = 0.161, CI 95%; 0.072-0.356, $p < 0.001$). Based on these results by increasing the age the IVDSP success decrease, but

Tab. III. The daily, weekly, monthly and seasonally prevalence of complementary consumption in girls' high schools.

Variables	No n (%)	Yes, n (%)				
		Every day	Every week	Every month	Every season	Seldom
High schools consumption						
Iron consumption	68 (17.00)	18 (4.5)	117 (29.25)	93 (23.25)	4 (1.00)	100 (25.0)
Vitamin D3	141 (35.25)	5 (1.25)	20 (5.0)	137 (34.25)	3 (0.75)	94 (23.50)
Home consumption						
Folic acid	295 (73.75)	3 (0.75)	25 (6.25)	41 (10.25)	1 (0.25)	35 (8.75)
Calcium	312 (78.00)	16 (4.0)	18 (4.50)	17 (4.25)	0 (0.00)	37 (9.25)
Zinc	300 (75.00)	10 (2.50)	20 (5.0)	19 (4.75)	2 (0.50)	49 (12.25)
Vitamin C	230 (57.50)	9 (2.25)	21 (5.25)	28 (7.0)	10 (2.50)	102 (25.50)
Multi Vitamin	286 (71.50)	10 (2.5)	8 (2.0)	10 (2.50)	6 (1.50)	80 (20.0)
Vitamin B	309 (77.25)	0 (0.00)	2 (0.50)	14 (3.50)	4 (1.0)	71 (17.75)
Other complementary drugs	355 (88.75)	2 (0.50)	1 (0.25)	10 (2.50)	3 (0.75)	29 (7.25)

Tab. IV. The relationship between of complementary consumption in high schools' girls with demographic variables.

Variable		Complementary consumption			p value
		Yes, n(%)	No, n (%)	Total	
Students contribution in explanatory session	Yes	24 (25.30)	71 (74.70)	95 (23.75)	0.003
	No	15 (37.50)	25 (62.50)	40 (10.00)	
	No educational Session	87 (32.80)	178 (67.20)	265 (66.25)	
Parents contribution in explanatory session	Yes	15 (25.90)	43 (74.10)	58 (14.50)	0.341
	No	19 (27.10)	51 (72.90)	70 (17.50)	
	No educational Session	92 (33.80)	180 (66.20)	272 (68.00)	
School session programs	Yes	58 (44.30)	73 (55.70)	131 (32.75)	0.001
	No	12 (24.50)	37 (75.50)	49 (12.25)	
	No educational Session	56 (25.50)	164 (68.50)	220 (55.00)	
Consumption surveillance	Yes	17 (26.60)	47 (73.40)	64 (16.00)	.465
	No	75 (33.90)	146 (66.10)	221 (55.25)	
	Sometimes	34 (29.60)	81 (70.40)	115 (28.75)	

contribution to explanatory programs enhancing the IVDSP prosperity.

Discussion

Our results showed that the overall utilization of IVDSP in high schools' girls is only 36.73%. The weekly prevalence of Iron and monthly prevalence of Vitamin D3 consumption was estimated 33.75% and 40.5%, respectively. Different studies in Iran showed that the utilization of this program in female high school students is weak. In Karimi et al. study on 440 middle school and high school female students from different areas of Semnan city [12], the results showed inappropriate consumption of Iron supplements, which was in line with the results of our study. Another study in Yazd girls showed that only 53.9% of middle school girls and 16.5% of high school girls consumed supplements completely [23]. In addition, in another mixed method (quantitative and qualitative) study by Khamarnia et al. in Zahedan on 400 randomly selected high school students from different regions, most of the students received Iron supplements irregularly or did not use them [13]. Dubik et al. study in Tamal Metropolis, Ghana also showed that 60% of the girls students did not take Iron and folic acid pills, which is consistent with the results of our study [24]. However, different results in a wide variety of students' selection are the most reasons. On the way, all studies showed that the efficacy of this program in Iran is insufficient and more activities is necessary to increase the efficiency of IVDSP.

Bad taste, Iranian made drug, drug sensitivity and drug interaction were the most common causes of non-consumption, respectively. In a similar qualitative study by Alami et al. the perceived challenges of the national plan of Iron supplement in schools assessed and target community of students, parents, school administrators and school health instructors interviewed in Gonabad city. They found that the bad taste of Iron pills was one of the main influencing factors in not taking Iron pills by students [25], which was consistent with the results of the present study. Another study in Zahedan bad taste and quality of Iron pills were the related factor of no usage Iron supplementation and they recommended the improvement of taste and quality of Iron pills for better consumption [13].

VDD prevalence estimated 76% in adolescents and approximately 93.9% of girls and 85.3% of

Tab. V. Comparing the mean of continues variables between two different groups of students in high schools based on complementary consumption.

Variable	Complementary consumption		p value
	Yes, Mean ± SD	No, Mean ± SD	
Age	15.24 ± 1.58	15.10 ± 1.49	0.382
Menarche age	14.59 ± 1.07	11.32 ± 1.32	0.043
BMI	20.55 ± 3.06	20.38 ± 3.18	0.624
Weight	52.65 ± 9.17	51.87 ± 8.36	0.400
High	159.86 ± 6.50	159.57 ± 7.50	0.695

pregnant women affected to this disorder [26, 27]. In addition, a systematic review and meta-analysis showed that the overall prevalence of Iron deficiency anemia in the Iranian population under 18 years of age was estimated at 13.9% and the overall prevalence of Iron deficiency was 26.9% [10]. Another study in the first and third grades of high schools in Yasuj city, showed this rate 32.3% and in the third grade, as 41.9% [28]. Several researches show that students with Iron deficiency anemia have significant differences in terms of doing schoolwork, recognition, problem solving, sensory and motor abilities, and memory power compared to healthy students [8]. The consequences of Iron deficiency anemia in adolescence have a negative impact on a person's reproductive performance in the future and the risk of low birth weight, premature birth, and abortion [12, 29]. Since millions of people suffer from Iron deficiency, this problem has a significant impact on economic and national development by reducing the quality of life of people, and it can be said that prevention of Iron deficiency and anemia caused by it has the greatest benefits for public health [8].

Despite the efforts of the Ministry of Health, Treatment and Medical Education in implementing free Iron supplement programs for adolescent groups, especially girls, the utilization and consumption of Iron and Vitamin D3 is low and this program was being unsuccessful [27]. Nevertheless, due to implementation of IVDSP, the consumption of Iron and Vitamin D is approximately 40%, while the monthly home consumption of other complementary micronutrients such as folic acid, calcium, zinc, Vitamin C, multi Vitamin and Vitamin B was lower than 8%. In addition, results of different studies in Iran showed that, the IVDSP has significant effect on decreasing the Iron deficiency and VDD and change multiple behavioral intention in female high school girls and prevent from worse outcomes in pregnancy in the future [30, 31].

This study was the first investigation to evaluate the effectiveness and utilization of IVDSP in Qom as strength, but some limitations were existing. Mineral interactions due to consumption foreign Iron or Vitamin D caused underestimation of estimates in our study. Some female high school' girls were using non-Iranian micronutrients and didn't use Iranian kind which distributed in schools. Moreover, the pattern of mineral distribution and micronutrients consumption manner was different among schools. High schools that have weekly distribution showed higher consumption in compared to schools that distributed all micronutrients' rations of students one time at first or monthly.

Conclusions

The inadequate and incomplete rate of IVDSP in Qom was high and more than 60% of distributed Iron and Vitamin D3 supplementations have been wasted. Our results showed that socioeconomic variables such as patents job and economic status of students are related factors of consumption of supplementations, but students who were participated in educational orientation classes were more successful and eager in Iron and Vitamin D3 consumption. However, regular weekly distribution of micronutrients suggested by authors for enhancing the IVDSP efficacy. Therefore, more support and educational explanatory interventions for both students and their parents recommended to increase the efficiency of the program.

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Conflict of interest statement

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Authors' contributions

All the authors assume responsibility for all content of the manuscript. All the authors contributed significantly to the conceptualization, drafting, and final editing of the manuscript.

References

[1] del Balzo V, Vitiello V, Germani A, Donini LM, Poggiogalle E, Pinto A. A cross-sectional survey on dietary supplements consumption among Italian teen-agers. PLoS One 2014;9:e100508. https://doi.org/10.1371/journal.pone.0100508.

[2] Gallagher CM, Black LJ, Oddy WH. Micronutrient intakes from food and supplements in Australian adolescents. Nutrients 2014;6:342-54. https://doi.org/10.3390/nu6010342.

[3] Alkhaldy HY, Hadi RA, Alghamdi KA, Alqahtani SM, Al Jabbar ISH, Al Ghamdi IS, Bakheet OSE, Saleh RAM, Shehata SF, Aziz S. The pattern of Iron deficiency with and without anemia among medical college girl students in high altitude southern Saudi Arabia. J Family Med Prim Care 2020;9:5018-25. https://doi.org/10.4103/jfmpc.jfmpc_730_20.

[4] Al-Daghri NM, Al-Saleh Y, Aljohani N, Sulimani R, Al-Othman AM, Alfawaz H, Fouda M, Al-Amri F, Shahrani A, Alharbi M, Alshahrani F, Tamimi W, Sabico S, Rizzoli R, Reginster JY. Vitamin D status correction in Saudi Arabia: an experts' consensus under the auspices of the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis, and Musculoskeletal Diseases (ESCEO). Arch Osteoporos 2017;12:1. https://doi.org/10.1007/s11657-016-0295-y.

[5] Holick MF, Chen TC. Vitamin D deficiency: a worldwide problem with health consequences. Am J Clin Nutr 2008;87:1080S-6S. https://doi.org/10.1093/ajcn/87.4.1080S.

[6] Hagenau T, Vest R, Gissel TN, Poulsen CS, Erlandsen M, Mosekilde L, Vestergaard P. Global Vitamin D levels in relation to age, gender, skin pigmentation and latitude: an ecologic meta-regression analysis. Osteoporos Int 2009;20:133-40. https://doi.org/10.1007/s00198-008-0626-y.

[7] Stevens GA, Paciorek CJ, Flores-Urrutia MC, Borghi E, Namaste S, Wirth JP, Suchdev PS, Ezzati M, Rohner F, Flaxman SR, Rogers LM. National, regional, and global estimates of anaemia by severity in women and children for 2000-19: a pooled analysis of population-representative data. Lancet Glob Health 2022;10:e627-39. https://doi.org/10.1016/S2214-109X(22)00084-5.

[8] McLean E, Cogswell M, Egli I, Wojdyla D, de Benoist B. Worldwide prevalence of anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993-2005. Public Health Nutr. 2009;12:444-54. https://doi.org/10.1017/S1368980008002401.

[9] Abidoye RO, Akande PA. Nutritional status of public primary school children: a comparison between an upland and riverine area of Ojo LGA, Lagos State Nigeria. Nutr Health 2000;14:225-40. https://doi.org/10.1177/026010600001400404.

[10] Akbari M, Moosazadeh M, Tabrizi R, Khatibi SR, Khodadost M, Heydari ST, Tahami AN, Lankarani KB. Estimation of Iron deficiency anemia in Iranian children and adolescents: a systematic review and meta-analysis. Hematology. 2017;22:231-9. https://doi.org/10.1080/10245332.2016.1240933.

[11] Mansourian M, Shafieyan Z, Qorbani M, Rahimzadeh Bazraki H, Charkazi R, Asayesh H, et al. Effect of nutritional education based on HBM model on anemia in Golestan girl guidance school students. J Health Educ Health Promot 2013;1:49-54.

[12] Karimi B, Zaker RH, Ghorbani R. Intake of Iron supplement and its related factors in jounior and high school girl students of the Iraninan population. Koomesh 2014;15:316-24.

[13] Khammarnia M, Amani Z, Hajmohammadi M, Ansari-Moghadam A, Eslahi M. A survey of Iron supplementation consumption and its related factors in high school students in Southeast Iran, 2015. Malays J Med Sci 2016;23:57-64. https://doi.org/10.21315/mjms2016.23.5.8.

[14] Mengistu G, Azage M, Gutema H. Iron deficiency anemia among in-school adolescent girls in rural area of Bahir Dar City Administration, North West Ethiopia. Anemia 2019;2019:1097547. https://doi.org/10.1155/2019/1097547.

[15] Naghibi SA, Ahmadi M, Afkhaminia F. Assessment of the Knowledge, Attitude, and performance of Female Junior High School Students of Neka, Iran, about Iron deficiency anemia in 2016. J Health Res Commun 2018;4:79-88.

[16] Tabrizi R, Moosazadeh M, Akbari M, Dabbaghmanesh MH, Mohamadkhani M, Asemi Z, Heydari ST, Akbari M, Lankarani KB. High prevalence of Vitamin D deficiency among Iranian population: a systematic review and meta-analysis. Iran J Med Sci 2018;43:125-139.

[17] Alipoor R, Gholami MS, Rajabi R, Anari MJ, Vaziri MS, Vajdi S, Shamshirian A. The prevalence of Iron deficiency anemia among high school students in Iran: a systematic review. Intern. Med Med Investig J 2017;2:1-6. https://doi.org/10.24200/imminv.v2i1.45.

[18] Ghazizadeh H, Rezayi M, Emadzadeh M, Tayefi M, Abdollahi Z, Timar A, Shaghi F, Saberi-Karimian M, Ferns GA, Elmadfa I, Meyer AL, Ghayour-Mobarhan M. Prevalence of Vitamin D deficiency in Iran: a systematic review and meta-analysis. J Cardiothorac Medicine 2022;10:945-73. https://doi.org/10.22038/jctm.2022.65411.1377.

[19] Faghih S, Abdolahzadeh M, Mohammadi M, Hasanzadeh J. Prevalence of Vitamin D deficiency and its related factors among University students in Shiraz, Iran. Int J Prev Med 2014;5:796-9.

[20] Ahadi Z, Asl LN, Ghardashi Z, Khosravi HM. Comparison of knowledge, attitude and practice of women toward Iron deficiency anemia and consumption of Iron supplements in Yazd and Orumiyeh. Jundishapur J Health Sci 2012;4:57.

[21] Naing L, Nordin RB, Abdul Rahman H, Naing YT. Sample size calculation for prevalence studies using Scalex and ScalaR calculators. BMC Med Res Methodol 2022;22:209. https://doi.org/10.1186/s12874-022-01694-7.

[22] Mohammadbeigi A, Mohammadsalehi N, Moshiri E, Asgarian A, Afrashteh S, Khazaei S, Ansari H, et al. Pattern of dietary supplement consumption among Iranian high school girls and related factors. Sri Lanka J Child Health 2020;49:41-7. https://doi.org/10.4038/sljch.v49i1.8897.

[23] Movahedi AF, Ahadi F. Prevalence of Iron deficiency anemia in high school girls in Semnan City. Journal of Shahid Sadoughi University of Medical Sciences Yazd 2005;12:14-14.

[24] Dubik SD, Amegah KE, Alhassan A, Mornah LN, Fiagbe L. Compliance with weekly Iron and folic acid supplementation and its associated factors among adolescent girls in Tamale Metropolis of Ghana. J Nutr Metab 2019;2019:8242896. https://doi.org/10.1155/2019/8242896.

[25] Alami A, Zarei F, Tehrani H, Hosseini Z, Jafari A. Perceived challenges of the Schools Iron Aid National Plan from stakeholder perspectives. Tehran University Medical Journal 2019;77:257-66.

[26] Vearing RM, Hart KH, Darling AL, Probst Y, Olayinka AS, Mendis J, Ribeiro H, Thakur S, Mendes M, Charlton K, Lanham-New SA. Global perspective of the Vitamin D status of African-Caribbean populations: a systematic review and meta-analysis. Eur J Clin Nutr 2022;76:516-26. https://doi.org/10.1038/s41430-021-00980-9.

[27] Aghapour B, Kheirouri S, Alizadeh M, Khodayari-Zarnaq R. Vitamin D deficiency prevention policies in Iran: a retrospective policy analysis. Front Nutr 2023;10:1249402. https://doi.org/10.3389/fnut.2023.1249402.

[28] Zohrabi T, Zohrabi M, Paknahad Z, Zandi GK, Negintaji A. The effect of Iron folic acid supplementation and dietary Iron

intake in high schools female students. Armaghane-Danesh 2015;19:817-827.

[29] Hosseini M, Shojaeizadeh D, Chaleshgar M, Pishva H. A study of educational intervention on knowledge, attitude, practice about Iron deficiency anemia in female adolescent students. Journal of Gorgan University of Medical Sciences 2006;8:37-43.

[30] Alami A, Ghelichi Ghojogh M, Hosseini Z, Jafari A. Effectiveness of Iron and Vitamin D supplementary intervention program in high school girl students. Iran J Health Educ Health Promot 2023;11:20-30.

[31] Alami A, Tavakoly Sany SB, Tehrani H, Lael-Monfared E, Hosseini Z, Jafari A. The effect of educational intervention on Iron and Vitamin D consumption based on the theory of planned behaviour in Iranian adolescent girls: a quasi-experimental study. Int J Health Promot Educ 2019;57:316-31. https://doi.org/10.1080/14635240.2019.1632732.

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HEALTH PROMOTION.

There is a correlation between nutritional status, Self-Rated Health and Life Satisfaction? Evidence from 2018 Health Behaviour in School-aged Children cross sectional study in a sample of Italian adolescents living in Tuscany Region

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Keywords

Obesity • Self-Rated Health • Life Satisfaction • Adolescents • Mental well-being

Summary

Background. *Overweight has been associated with several social and phycological problems and is perceived as one of the major health care challenges to focus on in the future. The purpose of the study is to investigate the correlations among nutritional status, assessed by the Body Mass Index, the perception of one's own health status and Life Satisfaction, detected in Italian adolescents living in Tuscany Region, and to investigate the influence of gender on them.*
Methods. *A statistically representative sample of 2760 Tuscan adolescents aged 11, 13 and 15 was involved in the 2018 Health Behaviours at School-aged Children survey. The participants were divided into three nutritional status class: underweight, normal weight and overweight (overweight + obese).*
Results. *The results show that there is a statistically significant difference in all categories between boys and girls aged 13 and 15 years; in girls aged 11 and 13 years, the Life Satisfaction of the overweight group is statistically lower than that of normal and underweight groups; Self-Rated Health is statistically lower in all age groups for overweight individuals compared to normal weight children, except for 11-year-old females.*
Conclusions. *Viewing the psychosocial problems related to overweight, more attention and care must be placed on adolescents to ensure their healthier development.*

Introduction

Adolescence is a unique developmental period representing the transition between childhood and adulthood and is characterized by great challenges and important physical and physiological changes. The quality of physical, social and nutritional environments may change trajectories of health [1-3]. Likewise, adolescence is also a "high-risk period" for weight gain. The World Health Organization (WHO) reports that one in three school-aged children, one in four adolescents and almost 60% of the adult population are overweight or obese [4].
Overweight and obesity cause more than 1.2 million deaths across the WHO European Region every year and are also the leading behavioural factor increasing the risk for disability. Prevalence of overweight and obesity among children and adolescents aged 5-19 has dramatically increased from 4% in 1975 to over 18% in 2016. Studies shows that the early childhood obesity correlates with a higher probability in adulthood to incur not only obesity but also a higher incidence of disability or even premature death [5]. Obesity is a complex disease, with multifaceted determinants and health consequences, and is considered a serious public health issue globally [5, 6]. Studies described obesity as a well-recognized risk factor for impaired Self-Rated Health (SRH), with a negative influence on subjective well-being and Life Satisfaction (LS) in different age groups, including adolescents [7-11]. SRH (also known as self-reported health or self-perceived health) refers to a single-item health measure in which people rate the current state of their own health using a four- or five-point scale from excellent to poor [12]. It is being adopted widely for its simplicity and is commonly implemented in public health studies. Despite its subjective nature, SRH has proved to be a good predictor of future health care needs [13]. The SRH status represents an individual's perceived health. Respondents are usually asked a question such as, "How is your health?". It is necessary to be prudent in performing comparisons between SRH. First of all, SRH is subjective, and answers may be different between and within countries due to sociocultural differences. Second, the subjective

health status of the general population declines with increasing age. Comparable findings have been found in other studies, which have shown that age is a risk factor for poor SRH [14, 15].

Well-being generally includes global judgments of LS, a concept associated with numbers of factors such as personal indicators, familiar and peer relationship factors [16, 17]. Since BMI is connected to many aspects of an individual's life, it is likely to have direct or indirect effects on person's overall LS. Indeed, overweight and obesity have been associated with lower subjective LS, with a deep impact on women. This trend has been observed also in teenage girls where lower level of LS is recorded compared to teenage boys [9, 10, 17-20]. Furthermore, body image (BI) is also strongly linked to LS. In the society, BI is recognized as the main cause of adolescent stress together with beauty. Specifically, BI becomes important in the adolescence development of one's self-concept and has an influence on self-esteem and interpersonal relations with peers [21]. Based on that, it is predictable that the higher the weight and the worse the BI, the worse the psychosocial indicators will be, and consequently, the subjective or perceived quality of life and LS [11, 18].

This study aimed to investigate the relationship between nutritional status, SRH, and LS in Tuscany Region Adolescents, as part of the Italian Health Behaviour in School-Aged Children (HBSC) survey.

Materials and methods

This study is based on the Italian HBSC 2018 study. HBSC is a WHO Collaborative Cross-National Survey run every four years. The sampling procedure and study methodology followed regularly updated international research guidelines [22]. As for the Italian Country, the Ministry of Health and the Ministry of Education have adopted HBSC as the national referral surveillance for adolescents. Therefore, the national sample was increased to reach regional representativeness [23]. According to the protocol, the school class was the primary sampling unit, and the participating schools were identified via systematic sampling from the Ministry of Education, University and Research list of all public and private schools. The final analytical Tuscany Region sample included 2760 adolescents aged 11, 13, and 15 years old [23]. A descriptive and cross-sectional study was designed. The research involved 2760 Tuscan adolescents (51.1% boys) of 11, 13 and 15 years old. A stratified multistage cluster random sampling method was used to recruit the participants.

When the participants' BMI data were coded, they were then grouped into the following three categories, using WHO standard deviation of BMI z score's reference: underweight (sd: < -2), normal weight ($-1 \leq$ sd < 1), overweight (sd: > 1), obese (sd: > 2) [24]. The Italian HBSC study protocol and questionnaire were formally approved by the Ethics Committee of the Italian National Institute of Health (PROT-PRE876/17, 20 November 2017).

The subjects completed the HBSC questionnaire [23], which evaluated, in addition to sociodemographic variables, the three variables under analysis.

Nutritional Status class. This was evaluated using the BMI, which was obtained through the weight and height data that was self-reported by the participants and calculated by the following equation: kg/m2. The validity of self-reported data in obtaining BMI in studies with children and youth has already been supported in previous research [25, 26]. According to their BMI, participants were grouped into the following categories: underweight, normal weight and overweight (which includes overweight and obese).

Self-rated health (SRH). The SRH measure assesses perceived health status. SRH was measured by the item "Would you say your health is?" (Response options were: "Excellent"; "Good"; "Fair" and "Poor").

Life Satisfaction (LS). To evaluate this variable, the Cantril Scale [27] was used, which is also included in the HBSC questionnaire. It consists of the following single item: "In general, where on the ladder do you feel you stand at the moment?" Responses range from 0 ("Worst possible life") to 10 ("Best possible life").

Data analysis

In order to determine whether there were differences in the variables under analysis (SRH and LS) based on participant gender, T-tests and Mann-Whitney test were performed. Additionally, an Analysis of Variance (ANOVA) and Krsukal-Wallis's test were carried out after checking the homogeneity between the groups, to determine whether there were mean differences in these variables based on the adolescents' weight category. The homoscedasticity assumption was checked using Levene's test. For the post hoc analysis of the differences found, the Bonferroni's correction test was performed. To study the effect of how weight status and gender interact in the variables under analysis, a multivariate ANOVA was carried out for LS. In all the analyses regarding differences, effect sizes (using Cohen's d, Eta-squared and Epsilon-squared) were examined with the corresponding tests. In order to determine whether there was a relation between categorical variables, a Chi-square test and Cramer's V to check the intensity of relation were used. All statistical analyses were performed using SPSS Version 22.0 for Windows (IBM Corp, Armonk, NY, USA).

Results

Descriptive analysis

Table I shows the sample distribution based on age, gender and BMI groups to which the participants belong. The results from Chi-square test, concluded that there was a statistically significant relationship between gender and BMI in general and in all age categories in the current sample ($p < 0.001$). As we can see, from the

Tab. I. Distribution of the sample according to the weight status of the participants, stratified by age-category and gender.

Age	N (%)	Sex	N (%)		Weight status		χ^2	Cramer's V
				Underweight	Normal weight	Overweight + obese	P[C]	
11	836 (30.3)	Boys	427 (51.1)[A]	63 (14.8)[B]	234 (54.8)[B]	130 (30.4)[B]	<.001	0.202
		Girls	409 (48.9)[A]	78 (19.1)[B]	275 (67.2)[B]	56 (13.7)[B]		
		Total	836 (100)[A]	141 (16.9)[B]	509 (60.9)[B]	1868 (22.2)[B]		
13	936 (33.9)	Boys	467 (49.9)[A]	63 (13.5)[B]	281 (60.2)[B]	123 (26.3)[B]	<.001	0.171
		Girls	469 (50.1)[A]	76 (16.2)[B]	333 (71.0)[B]	60 (12.8)[B]		
		Total	936 (100)[A]	139 (14.9)[B]	614 (65.6)[B]	183 (19.6)[B]		
15	988 (35.8)	Boys	515 (52.1)[A]	55 (10.7)[B]	355 (68.9)[B]	105 (20.4)[B]	<.001	0.169
		Girls	473 (47.9)[A]	74 (15.6)[B]	357 (75.5)[B]	42 (8.9)[B]		
		Total	988 (100)[A]	129 (13.1)[B]	712 (72.1)[B]	147 (14.9)[B]		
Total	2760 (100)	Boys	1409 (51.1)[A]	181 (12.8)[B]	870 (61.7)[B]	358 (25.4)[B]	<.001	0.177
		Girls	1351 (48.9)[A]	228 (16.9)[B]	965 (71.4)[B]	158 (11.7)[B]		
		Total	2760 (100)[A]	409 (14.8)[B]	1835 (66.5)[B]	516 (18.7)[B]		

[A] Percentage by Colum; [B] Percentage by Row; [C] Comparison between boys and girls.

Table I shows the results of all the participants, as well as boys and girls separately, by age category, for the variables under analysis, *i.e.*, Self-Rated Health (SRH) and Life Satisfaction (LS), based on the BMI category to which they belong.

values of Cramer's V, this association is weak in general (0.18) and in all age categories, also we noticed a major intensity in 11 years-old category (0.20).

LS and SRH based on adolescent gender

Student's t-test results show that there was a statistically significant difference between boys and girls in general and in 13 years-old and 15 years-old in the mean LS, with a very small effect size in general (Cohen's d = 0.17) and with a small effect size in 13 years-old (Cohen's d = 0.30) and 15 years-old (Cohen's d = 0.23). Similarly, SRH showed significant differences as well: in fact, there was a very small effect size in general (Cohen's d = 0.09), in 13 years-old (Cohen's d = 0.12) and 15 years-old (Cohen's d = 0.17). As shown in Table II, boys had higher LS (7.65 *vs* 7.34) than girls in general and in 13 years-old (7.82 *vs* 7.30) and 15 years-old (7.37 *vs* 6.93), as well as higher levels of SRH than their girls' peers (mean of rank statistics not showed in the table).

Comparing LS by weight status, we observe a significant difference between boys and girls in 13 years-old (Underweight, medium effect size, Cohen's d = 0.60 - Normal weight, small effect size, Cohen's d = 0.28 - Overweight small effect size, Cohen's d = 0.39) and 15 years-old (Normal weight, small effect size, Cohen's d = 0.28). Considering the sample as a whole, a significant difference is observed (in Underweight, very small effect size, Cohen's d = 0.20 - Normal weight, very small effect size, Cohen's d = 0.17 - Overweight, small effect size, Cohen's d = 0.30).

Comparing SRH and weight status, we observe a significant difference between boys and girls in 11 years-old (Normal weight, very small effect size, Cohen's d = 0.09), 13 years-old (Underweight, small effect size, Cohen's d = 0.30 - Normal weight, very small effect size, Cohen's d = 0.11) and 15 years-old (Underweight, very small effect size, Cohen's d = 0.20 - Normal weight, very small effect size, Cohen's d = 0.19 - Overweight, small

Tab. II. Life Satisfaction (LS) and Self-Rated Health (SRH) based on age category, gender and weight status of the participants.

Variable	Weight Status	11 years old				13 years old				15 years old				Total			
		Boys		Girls		Boys		Girls		Boys		Girls		Boys		Girls	
		Mean	SD	Mean[b,c]	SD	Mean	SD	Mean[b]	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
LS	Underweight	7.86	1.80	8.25	1.80	8.08[a]	1.27	7.08[a]	2.00	7.04[a]	1.85	6.50[a]	2.38	7.68[a]	1.70	7.29 a	2.19
	Normal weight	7.99	1.81	8.03	1.71	7.86[a]	1.55	7.43[a]	1.51	7.44[a]	1.46	7.00[a]	1.61	7.72[a]	1.61	7.44 a	1.66
	Overweight+Obese	7.88	1.87	7.35	1.89	7.59[a]	1.43	6.87[a]	1.99	7.30[a]	1.58	7.10[a]	1.32	7.61[a]	1.66	7.10 a	1.80
	Total	7.93	1.82	7.98	1.77	7.82[a]	1.49	7.30[a]	1.67	7.37[a]	1.54	6.93[a]	1.74	7.65[a]	1.71	7.34 a	1.85
		Median[b,c]	IR	Median	IR	Median[b,c]	IR	Median[b]	IR	Median[b]	IR	Median[b]	IR	Median[b,c]	IR	Median[bc]	IR
SRH	Underweight	3.00	[3,4]	4.00	[3,4]	4.00[a]	[3,4]	3.00[a]	[3,4]	3.00[a]	[3,4]	3.00[a]	[3]	3.00[a]	[3,4]	3.00[a]	[3,4]
	Normal weight	3.00[a]	[3,4]	3.00a	[3,4]	3.00[a]	[3,4]	3.00[a]	[3,4]	3.00[a]	[3,4]	3.00[a]	[3]	3.00[a]	[3,4]	3.00[a]	[3,4]
	Overweight+Obese	3.00	[3]	3.00	[3,4]	3.00	[3,4]	3.00	[3]	3.00[a]	[3]	3.00[a]	[2,3]	3.00	[3,4]	3.00	[3,3.2]
	Total	3.00	[3,4]	3.00	[3,4]	3.00	[3,4]	3.00	[3,4]	3.00	[3,4]	3.00	[3]	3.00	[3,4]	3.00	[3,4]

[a] Boys > Girls, <.001; [b] Overweight < Normal weight.001; [c] Overweight < Underweight.001.

Table II Shows how Life Satisfaction (LS) and Self-Reported Health (SRH) are related to the age, gender and weight status of adolescents.

effect size, Cohen's d = 0.22). In general, we observe a significant difference (in Underweight, very small effect size, Cohen's d = 0.16 - Normal weight, very small effect size, Cohen's d = 0.13).
As shown in Table II, boys had higher LS in general (Underweight, 7.68 *vs* 7.29 - Normal weight, 7.72 *vs* 7.44 - Overweight, 7.61 *vs* 7.10), 13 years-old (Underweight, 8.08 *vs* 7.08 - Normal weight, 7.86 *vs* 7.43 - Overweight, 7.59 *vs* 6.87), 15 years-old (Underweight, 7.04 *vs* 6.50 - Normal weight, 7.44 *vs* 7.00 - Overweight, 7.30 *vs* 7.10) than girls, as well as higher levels of SRH than their girls' peers (mean of rank statistics not showed in the table).

SRH and LS based on adolescent weight status

ANOVA results show that adolescents' BMI groups differed in LS, only for girls in 11 and 13 years old ($p < 0.001$). Effect sizes for both age categories were very low ($\eta 2 = 0.022$ and $\eta 2 = 0.016$ respectively). The Bonferroni's test showed the existence of significant differences between underweight and overweight ($p = 0.011$, Cohen's d = 0.29), normal weight and overweight ($p = 0.025$, Cohen's d = 0.22) in girls of 11 years old, normal weight and overweight ($p = 0.047$, Cohen's d = 0.20) in female of 13 years old.
Regarding results obtained from Kruskal-Wallis's test in SRH, we observe a statistically significant difference in general and in all categories of age ($p < 0.001$). Effect sizes were very low in all categories: 11-years old, (Boys) $\varepsilon 2 = 0.077$, (Girls) $\varepsilon 2 = 0.016$, 13-years old, (Boys) $\varepsilon 2 = 0.024$, (Girls) $\varepsilon 2 = 0.017$, 15-years old, (Boys) $\varepsilon 2 = 0.020$, (Girls) $\varepsilon 2 = 0.019$, Total, (Boys) $\varepsilon 2 = 0.031$, (Girls) $\varepsilon 2 = 0.007$, Total, $\varepsilon 2 = 0.013$). The Bonferroni's test showed the existence of significant differences between: underweight and overweight ($p < 0.001$, Cohen's d = 0.29), normal weight and overweight ($p < 0.001$, Cohen's d = 0.22) in boys of 11 years old, underweight and overweight ($p = 0.008$, Cohen's d = 0.29), normal weight and overweight ($p = 0.029$, Cohen's d = 0.22) in boys of 13 years old, normal weight and overweight ($p = 0.030$, Cohen's d = 0.22) in girls of 13 years old, normal weight and overweight ($p = 0.004$, Cohen's d = 0.22) in boys of 15 years old, normal weight and overweight ($p = 0.006$, Cohen's d = 0.22) in girls of 15 years old, underweight and overweight ($p < 0.001$, Cohen's d = 0.29), normal weight and overweight ($p < 0.001$, Cohen's d = 0.22) in boys, underweight and overweight ($p = 0.044$, Cohen's d = 0.29), normal weight and overweight ($p = 0.006$, Cohen's d = 0.22) in girls, underweight and overweight ($p < 0.001$, Cohen's d = 0.29), normal weight and overweight ($p < 0.001$, Cohen's d = 0.22) in general group.
Regarding the effect of the interaction, no analysis was performed for SRH, because non-parametric methods did not permit this type of test.
Regarding LS, when effect of the interaction was studied by means of a multivariate ANOVA, we have found significant interaction between age category and weight status, age category and gender. No interaction was found between gender and nutritional status.

Discussion

The aim of the study was to investigate the relationship between nutritional status, SRH, and LS as mediators of the association between obesity and impaired psychological well-being in Tuscany adolescents.
Our data showed that there is a statistically significant relationship between gender and BMI in general and in all age categories in the current sample ($p < 0.001$); furthermore, Student's t-test results show that there was a statistically significant difference between boys and girls in general and in age category 13 years-old and 15 years-old in the mean LS; in addition, boys have higher LS than girls in general and in 13 and 15 year age groups, as well as higher levels of SRH than their female peers.
Comparing LS and SRH by nutritional status class, we observe for both constructs a significant difference between boys and girls in 13 years-old and 15 years-old; in general, we observe a significant difference in underweight class. These findings are in agreement with other studies reporting differences between obese and normal-weight adolescents [10, 11, 18].
In general, obese subjects are exposed to prejudice and discrimination impairing their quality of life and causing numerous consequences for their psychological and physical health. It has been estimated that obesity prejudice has increased by 66% over the past decade in the USA and Europe [28].
The high prevalence of childhood obesity is recognized as a global public health priority. It is estimated that obesity affects > 107 million children worldwide, with the prevalence of pediatric obesity in high-income countries exceeding 20% [29]. This represents a two- or threefold increase of obesity rates among children at the country-specific level within the past 40 years [29]. The effects of obesity on health can also be lifelong and lead to an increasing in the risk of developing chronic diseases and early mortality [30].
Immediate and long-term psychosocial health consequences, such as reduced self-esteem and depression, also arise in children with ponderal excess [31, 32]. Of note, mental health concerns are the most commonly reported health risk among children with severe obesity [33], emphasizing the importance of incorporating psychological interventions into other aspects of obesity care. Weight stigma has a considerable impact on children that can affect their physical, mental and psychological health [32, 34-36].
Weight stigma may be particularly damaging when experienced during childhood and adolescence, whose internalization can result in a chronic stress response in addition to adverse medical consequences [28, 37, 38]. Weight stigmatization strengthens unhealthy lifestyle behaviours that contribute to obesity and is an unlikely method to induce successful weight lost. In adults it has

been recognized as an important risk factor for depression, low self-esteem, and body dissatisfaction [28].

It is useful to raise public awareness regarding obesity as a risk factor, that obesity increase the risk of life-threatening diseases and chronic conditions. In order to transform public awareness regarding obesity it is necessary to focus on advocacy and calls to action, *e.g.* on childhood obesity and life perspectives, combined with a new approach to public education campaigns supported by structural interventions. Furthermore, it is crucial to improve obesity-related health literacy at the local level.

While obesity increases the risk of developing life-threatening diseases and chronic conditions, which negatively impacts people and families, it also puts a heavy burden on public health expense, which has a negative impact on the society [39, 40].

Studies on childhood obesity and parental health literacy indicate that 'health literacy is a potentially undetected determinant of obesity, due to its influence on parents' opinions about their child's weight loss strategies and health information-seeking preferences, as well as health awareness in general' [41]. Furthermore, low levels of health literacy are associated with several determinants of health in adolescence, including body weight [42]. Health literacy is also associated with lower levels of cardiovascular diseases risk factors such as high BMI, metabolic syndrome in women and fatty liver disease [43].

The lack of success on standard obesity control measures reveals the need to develop a new, non-stigmatising approach to public policy, guided by multi-professional teams. Tackling obesity requires the involvement of general practitioners and experts such as endocrinologists, nutritionists, psychologists, behavioural counsellors, and physical fitness specialists; these figures, as well as teachers, and school staff, can play a key role towards this objective.

Stakeholder coordination between health professionals and policy makers through multi-professional teamwork, is crucial to assessing the burden of disease as well as confronting barriers in seeking treatment and performing screening [44].

In 2020, the European Commission formally established obesity as a chronic disease and has committed to assigning high priority to obesity as a major non communicable disease (NCD). Furthermore, measures have been implemented that will effectively deal with obesity as a chronic disease, including policy interventions that go beyond primary prevention and guarantee long-term and lifelong management [5]. Since 2021, the Model European Parliaments' (MEP) Informal Interest Group on Obesity and Resilient Health Systems has focused on the promotion of obesity as an NCD [5]. Conducting regular and continuous surveillance will have the potential to support policies and action plans to better monitor and assess the impact of diseases, and to measure the effectiveness of health policy interventions [45]. The groups' aspiration is to guarantee that obesity is accepted as a chronic disease based on its own definition, scope, and the way it is treated above and beyond primary prevention within policy instruments. The group also looks forward and considers resilient health systems and ecosystems in a more comprehensive sense beyond obesity.

Limitations of the study include the cross-sectional nature of the study, in this kind of study it is not possible to identify the temporal link between the outcome and the exposure because both are examined at the same time, and self-reported nature of the data, although under the supervision of teachers. Even more, the use of BMI as the sole measure to define overweight and obesity has its limitations, adding to the fact that the criteria for assessing obesity can change significantly depending on the references we consider. Therefore, could be important to harmonize these international standards for the categorization of childhood obesity.

Conclusions

More attention and care must be given regarding the psychosocial problems related to being overweight in adolescence; this is a very complex and delicate phase of development crucial to assure healthy development.

Future work is also required to better comprehend environmental influences on obesity. In addition to individual factors, work needs to better understand how other elements could influence risk of obesity. To this regard it could be useful to investigate why overweight boys have a higher LS than girls. Digital environments are another key factor in influencing health, and greater efforts needs to limit advertising unhealthy products online, especially for children and adolescence.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

GL: Conceptualization. AP: methodology and formal analysis. DL, VM, RS, LZ, GL: investigation. DL, AP, GL: data curation. CMT, DL, GL: writing - original draft preparation. DM, IM, TG: writing - review and editing; DL, AP, GL. visualization. GL: supervision and project administration. All authors have read and agreed to the published version of the manuscript.

References

[1] Jaworska N, MacQueen G. Adolescence as a Unique Developmental Period Jpn 2015;40:291-93. https://doi.org/10.1503/jpn.150268.

[2] Patton GC, Coffey C, Cappa C, Currie D, Riley L, Gore F, Degenhardt L, Richardson D, Astone N, Sangowawa AO, Mokdad A, Ferguson J. Health of the World's Adolescents: A Synthesis of Internationally Comparable Data. The Lancet 2012;379:1665-75. https://doi.org/10.1016/S0140-6736(12)60203-7.

[3] Patton GC, Olsson CA, Skirbekk V, Saffery R, Wlodek ME, Azzopardi PS, Stonawski M, Rasmussen B, Spry E, Francis K, Bhutta ZA, Kassebaum NJ, Mokdad AH, Murray CJL, Prentice AM, Reavley N, Sheehan P, Sweeny K, Viner RM, Sawyer SM. Adolescence and the next Generation. Nature 2018;54:458-66. https://doi.org/10.1038/nature25759.

[4] Todd A, Street S, Ziviani J, Byrne N, Hills A. Overweight and obese adolescent girls: the importance of promoting sensible eating and activity behaviors from the start of the adolescent period. IJERPH 2015;12:2306-29. https://doi.org/10.3390/ijerph120202306.

[5] WHO. Who European Regional Obesity Report 2022; European Obesity Report 2022. Copenhagen, Denmark: WHO 2022. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://apps.who.int/iris/bitstream/handle/10665/353747/9789289057738-eng.pdf (Accessed on: 20/02/2024).

[6] WHO. Obesity and overweight. WHO - Fact sheets. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (Accessed on: 20/02/2024).

[7] Park S. Pathways linking obesity to health-related quality of life. Qual Life Res 2017;26:2209-18. https://doi.org/10.1007/s11136-017-1565-x.

[8] Wadsworth T, Pendergast PM. Obesity (Sometimes) matters: the importance of context in the relationship between obesity and life satisfaction. J Health Soc Behav 2014;55:196-214. https://doi.org/10.1177/0022146514533347.

[9] Böckerman P, Johansson E, Saarni SI, Saarni SE. The negative association of obesity with subjective well-being: is it all about health? J Happiness Stud 2014;15:857-67. https://doi.org/10.1007/s10902-013-9453-8.

[10] Kuroki M. Life Satisfaction, overweightness and obesity. Intnl J Wellbeing 2016;6:93-110. https://doi.org/10.5502/ijw.v6i2.519.

[11] Baile JI, Guevara RM, González-Calderón MJ, Urchaga JD. The relationship between weight status, health-related quality of life, and life satisfaction in a sample of Spanish adolescents. IJERPH 2020;17:3106. https://doi.org/10.3390/ijerph17093106.

[12] Wu S, Wang R, Zhao Y, Ma X, Wu M, Yan X, He J. The relationship between self-rated health and objective health status: a population-based study. BMC Public Health 2013;13:320. https://doi.org/10.1186/1471-2458-13-320.

[13] OECD. Health at a Glance 2019: OECD Indicators; Health at a Glance; OECD 2019. Available at: https://doi.org/10.1787/4dd50c09-en (Accessed on: 20/02/2024).

[14] Molarius A, Berglund K, Eriksson C, Lambe M, Nordstrom E, Eriksson HG, Feldman I. Socioeconomic conditions, lifestyle factors, and self-rated health among men and women in Sweden. Eur J Public Health 2007;17:125-33. https://doi.org/10.1093/eurpub/ckl070.

[15] Murata C, Kondo T, Tamakoshi K, Yatsuya H, Toyoshima H. Determinants of self-rated health: could health status explain the association between self-rated health and mortality? Arch Gerontol Geriatr 2006;43:369-80. https://doi.org/10.1016/j.archger.2006.01.002.

[16] Simons G, Baldwin DS. A Critical review of the definition of 'wellbeing' for doctors and their patients in a post COVID-19 era. Int J Soc Psychiatry 2021;67:984-991. https://doi.org/10.1177/00207640211032259.

[17] Heshmat R, Kelishadi R, Motamed-Gorji N, Motlagh ME, Ardalan G, Arifirad T, Rastad H, Asayesh H, Djalalinia S, Larijani B, Qorbani M. Association between body mass index and perceived weight status with self-rated health and life satisfaction in Iranian children and adolescents: the CASPIAN-III Study. Qual Life Res 2015;24:263-72. https://doi.org/10.1007/s11136-014-0757-x.

[18] Habibov N, Auchynnikava A, Luo R, Fan L. A healthy weight improves life satisfaction. Int J Health Plann Mgmt 2019;34:396-413. https://doi.org/10.1002/hpm.2672.

[19] Jarosz E, Gugushviliì A. BMI and Dissatisfaction with Life: Contextual Factors and Socioemotional Costs of Obesity. Qual Life Res 2022;31(4):1167-1177. https://doi.org/10.1007/s11136-021-02912-3.

[20] Chen X, Cai Z, He J, Fan X. Gender differences in life satisfaction among children and adolescents: a meta-analysis. J Happiness Stud 2020;21:2279-307. https://doi.org/10.1007/s10902-019-00169-9.

[21] Choukas-Bradley S, Roberts SR, Maheux AJ, Nesi J. The perfect storm: a developmental-sociocultural framework for the role of social media in adolescent girls' body image concerns and mental health. Clin Child Fam Psychol Rev 2022;25:681-701. https://doi.org/10.1007/s10567-022-00404-5.

[22] Currie C, Inchley J, Molcho M, Lenzi M, Veselska Z, Wild F. Health behaviour in school-aged children (HBSC) study protocol: background, methodology and mandatory items for the 2013/14 survey. Available at: http://www.hbsc.org (Accessed on: 20/02/2024).

[23] Lazzeri G, Vieno A, Charrier L, Spinelli A, Ciardullo S, Pierannunzio D, Galeone D, Nardone, P. The methodology of the Italian Health Behaviour in School-Aged Children (HBSC) 2018 study and its development for the next round. J Prev Med Hyg 2021;62:E926-E93. https://doi.org/10.15167/2421-4248/JPMH2021.62.4.2343.

[24] WHO. Growth Reference Data for 5-19 Years. Available at: https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age (Accessed on: 05/04/2024).

[25] Forste R, Moore E. Adolescent obesity and life satisfaction: perceptions of self, peers, family, and school. Econ Hum Biol 2012;10:385-94. https://doi.org/10.1016/j.ehb.2012.04.008.

[26] Jalali-Farahani S, Zayeri F, Zarani F, Azizi F, Amiri P. Network associations among body image, lifestyle, body mass index, and quality of life in adolescents. Int J Endocrinol Metab 2022;20:e123237. https://doi.org/10.5812/ijem-123237.

[27] Mazur J, Szkultecka-Dębek M, Dzielska A, Drozd M, Małkowska-Szkutnik A. What does the cantril ladder measure in adolescence? Arch Med Sci 2018;14:182-9. https://doi.org/10.5114/aoms.2016.60718.

[28] Puhl RM, Heuer CA. Obesity stigma: important considerations for public health. Am J Public Health 2010;100:1019-28. https://doi.org/10.2105/AJPH.2009.159491.

[29] Haqq AM, Kebbe M, Tan Q, Manco M, Salas XR. Complexity and stigma of pediatric obesity. Childhood Obesity 2021;17:229-40. https://doi.org/10.1089/chi.2021.0003.

[30] Lee EY, Yoon KH. Epidemic obesity in children and adolescents: risk factors and prevention. Front Med 2018;12:658-66. https://doi.org/10.1007/s11684-018-0640-1.

[31] Libbey HP, Story MT, Neumark-Sztainer DR, Boutelle KN. Teasing, disordered eating behaviors, and psychological morbidities among overweight adolescents. Obesity 2008;16(Suppl 2):S24-9. https://doi.org/10.1038/oby.2008.455.

[32] Madowitz J, Knatz S, Maginot T, Crow SJ, Boutelle KN. Teasing, depression and unhealthy weight control behaviour in obese children: teasing effects in an obese child sample. Pediatric Obesity 2012;7:446-52. https://doi.org/10.1111/j.2047-6310.2012.00078.x.

[33] Hadjiyannakis S, Ibrahim Q, Li J, Ball GDC, Buchholz A, Hamilton JK, Zenlea I, Ho J, Legault L, Laberge AM, Thabane L,

Tremblay M, Morrison KM. Obesity class versus the edmonton obesity staging system for pediatrics to define health risk in childhood obesity: results from the CANPWR Cross-Sectional Study. Lancet Child Adolesc Health 2019;3:398-407. https://doi.org/10.1016/S2352-4642(19)30056-2.

[34] Guardabassi V, Mirisola A, Tomasetto C. How is weight stigma related to children's health-related quality of life? A model comparison approach. Qual Life Res 2018;27:173-83. https://doi.org/10.1007/s11136-017-1701-7.

[35] Puhl RM, Wall MM, Chen C, Bryn Austin S, Eisenberg ME, Neumark-Sztainer D. Experiences of weight teasing in adolescence and weight-related outcomes in adulthood: a 15-year longitudinal study. Prev Med 2017;100:173-9. https://doi.org/10.1016/j.ypmed.2017.04.023.

[36] Schvey NA, Marwitz SE, Mi SJ, Galescu OA, Broadney MM, Young-Hyman D, Brady SM, Reynolds JC, Tanofsky-Kraff M, Yanovski SZ, Yanovski JA. Weight-based teasing is associated with gain in BMI and fat mass among children and adolescents at-risk for obesity: a longitudinal study. Pediatr Obes 2019;14:e12538. https://doi.org/10.1111/ijpo.12538.

[37] Bayram S, Köseler Beya E, Fatma Türker P, Saka M. The Evaluation of Obesity Prejudices among Adolescents. Act Scie Nutr 2019;3:166-71. https://doi.org/10.31080/ASNH.2019.03.0552.

[38] Hand WB, Robinson JC, Stewart MW, Zhang L, Hand SC. The identity threat of weight stigma in adolescents. West J Nurs Res 2017;39:991-1007. https://doi.org/10.1177/0193945917704201.

[39] OECD. The Heavy Burden of Obesity: the Economics of Prevention; OECD Health Policy Studies; OECD 2019. Available at: https://doi.org/10.1787/67450d67-en (Accessed on: 20/02/2024).

[40] Ling J, Chen S, Zahry NR, Kao TA. Economic burden of childhood overweight and obesity: a systematic review and meta-analysis. Obes Rev 2023;24:e13535. https://doi.org/10.1111/obr.13535.

[41] Marks R. Childhood obesity and parental health literacy. Adv Obes Weight Manag Control 2015;3:191-95. https://doi.org/10.15406/aowmc.2015.03.00055.

[42] Lam LT, Yang L. Is low health literacy associated with overweight and obesity in adolescents: an epidemiology study in a 12-16 years old population, Nanning, China, 2012. Arch Public Health 2014;72:11. https://doi.org/10.1186/2049-3258-72-11.

[43] Cheng YL, Shu JH, Hsu HC, Liang Y, Chou RH, Hsu PF, Wang YJ, Ding YZ, Liou TL, Wang YW, Huang SS, Lin CC, Lu TM, Leu HB, Lin SJ, Chan WL. High Health Literacy Is Associated with Less Obesity and Lower Framingham Risk Score: Sub-Study of the VGH-HEALTHCARE Trial. PLoS ONE 2018;13:e0194813. https://doi.org/10.1371/journal.pone.0194813.

[44] Tiwari A, Balasundaram P. Public health considerations regarding obesity. In: StatPearls. Treasure Island, FL: StatPearls Publishing 2023.

[45] Bel-Serrat S, Huybrechts I, Thumann BF, Hebestreit A, Abuja PM, de Henauw S, Dubuisson C, Heuer T, Murrin CM, Lazzeri G, van Rossum C, Andersen LF, Szeklicki R, Vioque J, Berry R, van der Ploeg HP, Ahrens W, Slimani N; DEDIPAC Consortium. Inventory of surveillance systems assessing dietary, physical activity and sedentary behaviours in Europe: a DEDIPAC study. Eur J Public Health 2017;27:747-55. https://doi.org/10.1093/eurpub/ckx023.

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HELATH CARE MANAGMENT

Characteristics of the health districts in Italy and their implication in primary health care policies: an analysis of socio-demographic trends

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Keywords

Primary Health Care • Demography • Delivery of Health Care • Comprehensive Health Care • Population Health • Community Health Services • Inner Areas Score

Summary

Introduction. *The Health District (HD) is a critical component of Italy's National Health Service, responsible for ensuring Primary Health Care (PHC) services in response to community health needs. The Italian government established a national strategic reform program, the National Recovery and Resilience Plan (PNRR), starting in 2022, with a series of health interventions to reorganize the PHC setting, the main reform being the Ministerial Decree 77/2022 (DM77). Our study aimed to provide a description of socio-demographic data and to assess the correlation between HDs, in order to suggest health intervention priorities in PHC reforms.*

Materials and methods. *We conducted our analysis using a cross-sectional record linkage of data from multiple sources to compare organizational and socio-demographic variables. A dataset was created with each of the 21 Italian Regions' HDs data of population, land area, mean age, ageing index, old-age dependency ratio, birth rate and death rate. The Inland Areas Project data was integrated for a socio-economic perspective.*

Results. *Our study identified comparable groups of HDs, considering demographical, socio-economic and geographical aspects. The study provides a baseline understanding of the Italian situation prior to the implementation of DM77. It also highlights that inhabitants number cannot be the only variable to take into account for the definition of Italian HDs organisation and PHC reform, providing intercorrelated variables that take into account geographic location, demographic data, and socio-economic aspects.*

Conclusion. *By acknowledging the interplay of demographic, socio-economic, and geographic factors, policymakers can tailor interventions to address diverse community needs, ensuring a more effective and equitable PHC system.*

Introduction

In the Italian National Health System, the Health District (HD) is an articulation of the Local Health Authorities (LHAs) that is responsible for ensuring Primary Health Care (PHC) services to address community health needs. In Italy, together with the inauguration of a Beveridge-model taxes-funded National Health Service (NHS) [1], the concept of HD was introduced in 1978. Following a reform process based on principles of corporatization, NHS laws during the 90s [2] clarified HD functions as a centre of governance to provide social and health care integration. These reforms also set parameters like HD size (initially 60,000 people per HD, considering territorial and demographic aspects), and defined the role and functions of the Director of HD.

Subsequently, in 2001, the need to guarantee essential levels of care ("Livelli Essenziali di Assistenza", LEA) was reaffirmed, and a balanced budget for all Regional health systems was from then on required. In the same year, the amendment of Title V of the Italian Constitution [3] granted more autonomy to Regions in healthcare management, leading to a kind of healthcare federalism. Consequently, although the HD's functions and roles have been nationally defined in increasing detail over the years, the organisational features of the 21 Regional health care systems and the HDs have become extremely heterogeneous [4]. In the past decades many LHAs were merged, increasingly enlarging their catchment area, both in terms of population served and territorial extent (from 659 LHAs in 1992 to 99 LHAs as of 2021): Italian HDs, affected by this evolution, now have various organisational assets depending on Regional Laws and dispositions.

As a result of the pandemic and the ensuing economic crisis, the Italian government launched the National

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Recovery and Resilience Plan ("Piano Nazionale di Ripresa e Resilienza", PNRR) a reform program consisting of six financial assets, one of which related to the health sector, more specifically to PHC. In line with the PNRR, Ministerial Decree 77/2022 (DM 77) [5] redefined the organisational standard of the HD, including a population basin of 100,000 inhabitants and at least one community health centre, called Community House ("Casa della Comunità'', CdC) for every 40,000-50,000 inhabitants. Within the plan, the HD is identified as a place for application of new standards of care and for integration of all healthcare services of the LHAs [6]. Although, in the last decade, assessments by entities such as the National Agency for Regional Health Services ("Agenzia Nazionale per i Servizi sanitari regionali", AgeNaS) were published, detailed analyses focusing on the Italian HDs have been lacking [7]. Acknowledging the need for updated data on the Italian HDs, the authors conducted a study focusing on the socio-demographic situation as of January 1st, 2021. In particular, the study aim was to (i) carry out a quantitative description of the district articulations of the Italian LHAs and their territorial extension to 2021, (ii) provide a descriptive analysis of the socio-demographic data of the population residing in each HD and (iii) assess clustering of HDs with homogeneous features, (iv) assess clustering implications, in order to suggest health intervention priorities to meet the needs of the population.

Materials and methods

In the absence of a common official Italian database with information about HDs, along with the municipalities led by them, a cross-sectional record linkage analysis was conducted, to recreate it, by collecting data from various sources (Italian Ministerial documents and LHAs websites). Using data from the Italian National Institute of Statistics (Istat), we then gathered the following data for every municipality in the Italian territory, updated to January 2021:

- population;
- land area in square kilometres;
- mean age of the population;
- ageing index (ratio of population aged 65 years and older to population aged 0-14 years, multiplied by 100);
- old-age dependency ratio (ratio of population of non-working age, of 0-14 years and 65 years and older, to population of working age, of 15-64 years, multiplied by 100);
- birth rate (ratio of the number of live births for the year to the average amount of the resident population, multiplied by 1,000);
- death rate (ratio of the number of deaths for the year to the average amount of the resident population, multiplied by 1,000).

Data analysis and summarisation were performed using Microsoft Excel® for Microsoft 365 MSO (Version 2301 Build 16.0.16026.20196) 32 bit. To note, usually a single HD comprehends more than one municipality: out of 7,904 municipalities, in particular, 7,897 municipalities are part of just one HD. On the contrary, 7 municipalities, among the most populated of Italy, are divided into multiple HDs; in the database, they were inserted as separate entries with divided attributes.

To assess the impact of geographic characteristics on the population's health needs and HDs organisational setting, the municipalities were further categorised. Since a consensus in medical literature on the best way to categorize HDs territorial geography was not found, they were analyzed in light of the categories available in the framework of the Italian Ministry of the Interior's Inland Areas Project: the "Map of Inland Areas for the 2021-2027 cycle" ("Strategia Nazionale Aree Interne") [8], the latest publicly available downloadable dataset at the time of analyses for this study. In the document, the concept of Inland Area is defined as *those areas significantly distant from the centres that supply essential services (education, health and mobility), rich in environmental and cultural resources* [9]. In Italy, to date about a quarter of the population lives in these areas, in a portion of territory that exceeds 60% of the total territory.

Based on the above-mentioned document, 6 groups of municipalities can be identified:

- A - Pole;
- B - Intermunicipal Pole;
- C - Belt;
- D - Intermediate;
- E - Peripheral;
- F - Ultraperipheral.

Since the aim of our study was to assess each HDs' characteristics, we developed a score, called Inner Areas Score (IAS) in order to categorize HDs consisting of municipalities belonging to different groups. HDs were analyzed by defining a score for each of them on the basis of the municipalities therein, who were given:

- 1 point for municipalities in A area;
- 2 points for B;
- 3 points for C;
- 4 points for D;
- 5 points for E;
- 6 points for F.

After that, we determined the HDs' IAS based on the arithmetic mean of the composing municipalities' IAS. At the end of this process, each HD was assigned a score between 1 and 6 and; based on the score, HDs were categorised as follows: Central HDs (scores between 1 and 2); Intermediate HDs (scores between 3 and 4); Peripheral HDs (scores between 5 and 6).

Unless otherwise stated, categorical variables were summarised by frequencies and percentages. Median and interquartile ranges (IQR) were used to show continuous variables. We calculated descriptive statistics to identify the characteristics of the HDs' population and we stratified our sample for Regions. Furthermore, a univariate and bivariate analysis was conducted using the IBM SPSS Statistics Software version 28.0.1.0; we consider p-value set at < 0.05 as statistically significant.

The main results were highlighted by chi-square tests. Student's t test for independent samples was carried out. Shapiro-Wilk tests were used to assess normal data distribution, which resulted in a non-normal distribution for all variables ($p < 0.001$) (as shown in Tab. IV), except for the old-age dependency ratio ($p = 0.2$). Thus, parametric statistical tests were used exclusively for the old-age dependency ratio, while non-parametric tests (Mann-Whitney U test for independent samples) were used for all other variables. We used post-hoc Bonferroni correction to analyse categorical variables with multiple groups. We performed an ANOVA test on the old-age dependency ratio and the Kruskal-Wallis test on other variables. Furthermore, we used the Mann-Whitney U test to compare variables that appear to have statistically significant differences for each pair of groups in the post-hoc tests. To keep the alpha error at 5% we applied Bonferroni's corrective test: p-value = a/n, where alpha is the significance level and n is the number of post-hoc tests (*e.g.* 3 post-hoc tests need a Bonferroni correction of < 0.017 (0.05/3).

Results

Descriptive analysis of the Italian Health Districts Organizations and Policies

As of January 1st, 2021, the Italian territory included 7,904 municipalities and was subdivided in 545 HDs. Each HD included a median of 9 municipalities (IQR: 4-19) and covered an area of 419 square kilometres (IQR: 186-782 km^2). The total Italian population was 59,236,213 inhabitants [10]. Each HD provided services to a median population of 80,418 (IQR: 51,968-124,132 inhabitants), with extreme data regarding the Merano-Circondario HD in Bolzano Autonomous Province (1,380 inhabitants) and the Milan HD (1,374,582 inhabitants). The median population density was 194.3 persons/km^2 (IQR: 85.7-524.9; min: 13.6 persons/km^2 in Umbria Valnerina HD; max: 17,958.1 persons/km^2 in Campania HD 31).

As of 2021, the Italian population was reported to be 45.9 years old on average [11]. At the District level, a median of 46.1 years was observed (IQR: 44.7-47.6 years): the HD that recorded the lowest mean age was the Succivo District (38.4 years), in Campania, while the Italian HD with the highest mean age was Alto Vastese HD in Abruzzo (51.1 years). The national registered ageing index was 182.6 [12]. At the District level, a median ageing index of 191.4 was observed (IQR: 162.9-227 years): the lowest was 70.2 in Succivo HD, and the highest was 389.7 in Alto Vastese HD in Abruzzo. When compared to a national old-age dependency ratio of 57.3 [12], marked differences could be observed between HDs in terms of the social and economic burden of the inactive population: in 2021, a median ratio of 57.8 was observed (IQR: 54.7-60.8); the lowest value of 43.3 was recorded in Campania HD 47 while at the opposite extreme there was a maximum of 72.9 in the Alto Vastese HD of Abruzzo.

The birth rate in Italy, updated to 2021, was 6.8 per thousand inhabitants [12]. The median birth rate per HD was 6.7 per thousand inhabitants (IQR: 6-7.4): the lowest value was recorded in the HD of Ovada in Piedmont (4.1 per thousand inhabitants) and the highest birth rate was in the Bolzano HD of Val Passiria (14 per thousand inhabitants). Compared with a death rate of 11.9 in Italy [12], the HDs' average was 12.2 deaths per thousand inhabitants (IQR: 11-13.8); the lowest value was registered in Succivo HD in Campania (6.9 deaths per thousand inhabitants), and the highest was registered in the Alto Vastese HD (21.2 deaths per thousand inhabitants).

According to data as of 2021, strong variability among HDs per Region was reported. In every Region, there was an average of 22 HDs (IQR: 13-37), and every HD included typically 13 municipalities (IQR: 9-19). The catchment area ranged from a mean of 25,472 inhabitants per HD for Bolzano to a mean of 415,898 inhabitants in Lombardy. In extreme cases the differences were huge: for example, there is a marked contrast between Lombardy Region (almost 10 million inhabitants in 24 districts) and Campania Region (5.6 million inhabitants in 72 districts). The population density was on average 327.3 inhabitants per square kilometre (min: 42.7 in Valle D'Aosta; max: 2,070.7 in Campania).

The youngest Region was the Autonomous Province of Bolzano (mean age of 42.5 years) and the oldest was Liguria (mean age of 49.3 years). Likewise, the ageing index in 2021 was highest in Liguria (269.8) and lowest in Bolzano (119.1). The old-age dependency ratio in 2021 was highest in Liguria (66.3) and lowest in Campania (54.2). The average birth rate was highest in Bolzano (10.2 per thousand inhabitants) and lowest in Sardinia (5.1 per thousand inhabitants). The average death rate was highest in Liguria (16.8 per thousand inhabitants) and lowest in Bolzano (9.8 per thousand inhabitants). Table I summarises the main characteristics of HD's population, divided by Regions, as of 2021.

Comparing the current standard of 100,000 inhabitants per HD [5] with the catchment area of the HDs as of 2021, it was observed that 200 (37%) of them were oversized. Notably, the distribution by Region was very heterogeneous, ranging from Valle D'Aosta whose HDs were all within the set standard to Lombardy where 22 out of 24 HDs (91.7%) showed a population exceeding 100,000 inhabitants. This data is shown in Table II.

Although there was ample inter-district and inter-regional variability, the prevailing IAS was urban: overall, 135 (24.8%) of the 545 HDs consist of predominantly Central Poles, 361 (66.2%) Intermediate Areas, while only 49 HDs (9,0%) fall under the definition of Peripheral Area. The Region with the highest percentage of HDs whose catchment area was predominantly metropolitan was Friuli-Venezia-Giulia (50%). Calabria, Molise and Valle D'Aosta Regions had exclusively HDs with intermediate territorial scores. The Basilicata Region had the highest percentage of peripheral municipalities (55.6%). Data are shown in Figure 1.

Tab. I. HDs' population and demographic characteristics by Region until January 2021.

Region	N° LHAs	N° HDs	Municipalities (mean)	Population (Region)	Catchment area per HD			Mean age	Aging index	Dependency ratio	Natality	Mortality
					Min	Mean	Max					
Abruzzo	4	16	19	1,281,012	17,751	80,063	205,685	47.3	231.5	60.5	6.2	13.1
Basilicata	2	9	15	54,513	22,684	60,570	149,381	46.8	229.4	56.4	6.2	12.6
Calabria	5	16	25	1,860,601	25,098	116,288	253,252	45.2	185.0	57.2	7.5	11.4
Campania	7	72	8	5,624,260	30,230	78,115	159,745	43.4	148.0	52.4	7.9	10.5
Emilia-Romagna	8	37	9	4,441,353	32,220	120,037	391,686	46.5	195.9	59.3	6.6	13.4
Friuli-Venezia-Giulia	3	22	10	1,201,510	11,282	54,614	158,122	48.2	242.2	63.0	6.0	14.1
Lazio	10	40	10	5,730,399	31,164	143,26	314,135	45.6	176.0	55.3	6.6	10.9
Liguria	5	19	13	1,518,495	31,689	79,921	146,390	49.3	269.8	66.3	5.7	16.8
Lombardy	8	24	63	9,981,554	36,992	415,898	1,374,582	45.7	179.5	57.4	6.8	14.0
Marche	1	13	17	1,495,820	43,822	115,063	251,074	47.3	218.6	61.2	6.2	13.5
Molise	1	3	45	294,294	81,415	98,098	117,446	47.6	248.2	59.0	5.8	13.6
P.A. Bolzano	1	21	6	534,912	1,380	25,472	107,467	42.5	119.1	52.8	10.2	9.8
P.A. Trento	1	13	13	542,166	9,685	41,705	143,381	45.1	167.9	56.8	7.4	12.0
Piedmont	12	47	25	4,274,945	21,210	90,956	257,453	47.6	227.4	62.3	6.2	15.6
Puglia	6	45	6	3,933,777	37,128	87,417	317,205	45.5	186.6	56.2	6.7	11.3
Sardegna	1	24	16	1,590,044	10,722	66,252	248,690	48.3	260.3	58.9	5.1	12.5
Sicily	9	55	7	4,833,705	7,366	87,886	730,687	45.3	184.2	57.0	7.4	12.1
Tuscany	3	26	11	3,692,865	31,477	142,033	368,419	47.7	228.2	61.8	5.9	13.2
Umbria	2	13	7	865,452	11,315	66,573	192,756	47.9	231.9	63.3	5.9	13.1
Val d'Aosta	1	4	19	124,089	16,028	31,022	61,750	46.7	199.7	58.5	6.3	14.5
Veneto	9	26	22	4,869,830	25,604	187,301	315,158	46.4	194.5	57.4	6.6	11.9
Italy	**99**	**545**	**17**	**59,236,213**	**1,380**	**108,690**	**1,374,582**	**46.1**	**196.3**	**57.9**	**6.8**	**12.5**

Statistical multivariate analyses

After a preliminary descriptive analysis, bivariate analysis was carried out. We analysed data from the 2021 population after dividing HDs into two categories: HDs with more than 100,000 inhabitants and HDs with 100,000 inhabitants or less, given the cutoff identified by DM77 [5].

As expected, HDs with a population > 100,000 inhabitants usually had a higher number of municipalities, land area and population density and statistically significantly lower old-age dependency ratio values, when compared to the other HD groups.

The demographic indexes (mean age, ageing index, birth rate index, mortality index) had shown no statistically significant differences between HDs with less or more than 100,000 inhabitants (shown in Tab. III).

Central HDs present a smaller number of municipalities and mean surface area, while on the contrary, the mean population and population density were bigger than the other Areas, as shown in Table VI.

As shown in Tables V and VI, there was no statistically significant difference regarding the old-age dependency ratio and death rate index, while there were statistically significant differences for mean age, ageing index, which are lower, and birth rate index, which is higher, in Central HDs compared to other HDs.

Post-hoc test with Bonferroni correction was performed on categorical variables (Tab. VII) and showed statistically significant differences between the Central and Peripheral HDs, rather than between contiguous areas HDs (Central vs. Intermediate or Intermediate vs. Peripheral); in other words, differences could be seen more clearly between extreme data.

Discussion

This paper undertakes a comprehensive analysis of Italian PHC population and structure focusing on the Local HDs, a crucial component of the ongoing reform process.

The study, conducted before the DM 77 [5] shaped the primary healthcare setting, might serve as a baseline for subsequent studies on implementation and deployment

Tab. II. Number of Districts by Region and Population Size until January 2021.

Region	District Population				Total
	< 100.000 ab.	%	> 100.000 ab.	%	
Abruzzo	11	68.8%	5	31.3%	16
Apulia	37	82.2%	8	17.8%	45
Basilicata	7	77.8%	2	22.2%	9
Bolzano	20	95.2%	1	4.8%	21
Calabria	5	31.3%	11	68.8%	16
Campania	60	83.3%	12	16.7%	72
Emilia-Romagna	17	45.9%	20	54.1%	37
Friuli-Venezia-Giulia	21	95.5%	1	4.5%	22
Lazio	13	32.5%	27	67.5%	40
Liguria	13	68.4%	6	31.6%	19
Lombardy	2	8.3%	22	91.7%	24
Marche	4	30.8%	9	69.2%	13
Molise	2	66.7%	1	33.3%	3
Piedmont	31	66%	16	34%	47
Sardinia	19	79.2%	5	20.8%	24
Sicily	43	78.2%	12	21.8%	55
Trento	12	92.3%	1	7.7%	13
Tuscany	9	34.6%	17	65.4%	26
Umbria	11	84.6%	2	15.4%	13
Valle d'Aosta	4	100%	0	0%	4
Veneto	4	15.4%	22	84.6%	26
Italy	**345**	**63.3%**	**200**	**36.7%**	**545**

of the reforms in PHC and, in general, to make more conscious organisational decisions in PHC settings.

In accordance with the previous studies [4, 7], the present analysis confirms high heterogeneity in population density and land area extension in all HDs of each Italian Region (as shown in Tab. I and II), which is likely driven by a historically different implementation of the PHC services in HDs due to different Regional visions and municipalities compositions. The data collected implies, indeed, a diversity of conceptual models that could result in substantial differences in characteristics and volumes of offered services [7].

Moreover, this heterogeneity may be linked to the profound geographical and population distribution differences in Italy: as of now, Italian Regions have extremely various characteristics and areas, that range from mainly mountainous and small Regions like Valle D'Aosta (124,089 inhabitants) to more central and populous Regions like Lombardy (9,981,554 inhabitants).

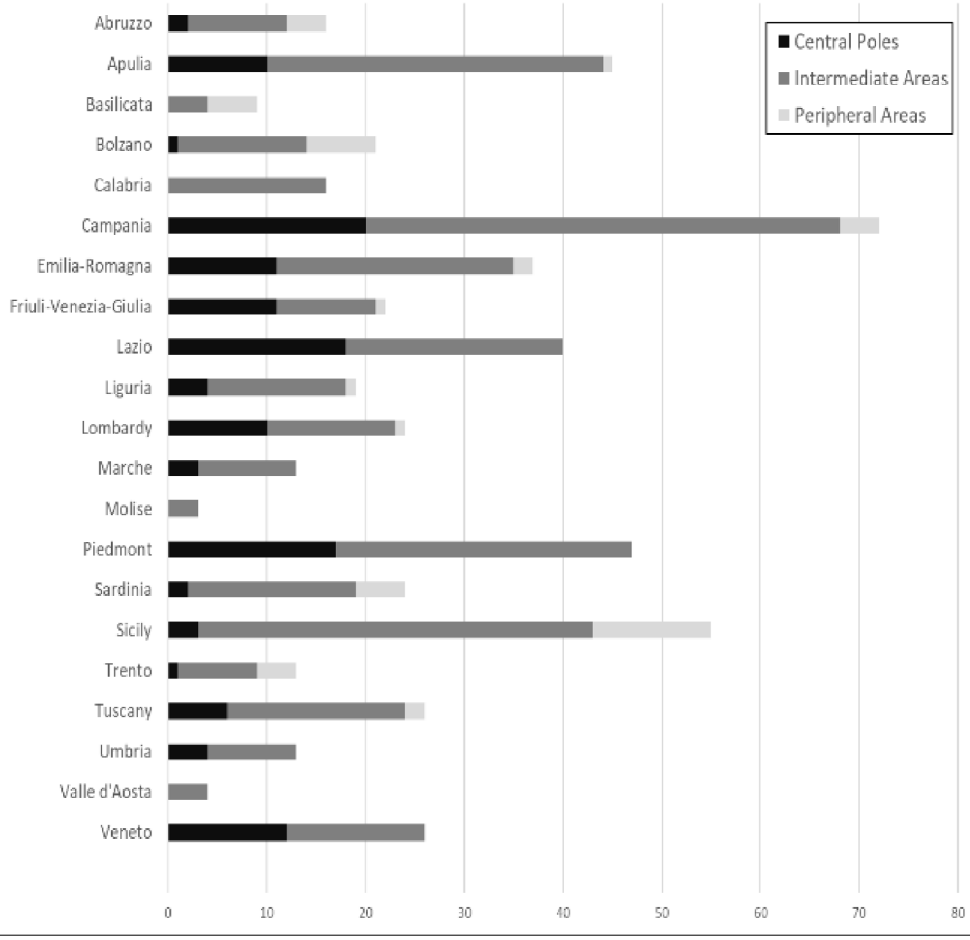
When studying HD composition, factors such as demographics (*e.g.* age or sex) and socio-economic status (*e.g.* income level, education level and employment) may have an impact on services utilisation if population composition substantially differs between geographical areas [7,13]. On the other hand, differences in geographically related factors, such as the number and type of healthcare facilities, may also lead to geographical disparities in healthcare use [14].

For these reasons, the study recommends a nuanced approach, beyond mere population numbers, for effective standardisation of HDs.

Considering demographic aspects, Italy's population (59,236.213 residents as of 2021) has been declining over the last decade. The average age has risen by three years since 2011 (from 43 to 46, as shown in Tab. I) [15]. The 2021 age structure is confirmed to be strongly imbalanced in favour of the elderly component of the population [15], with Italian population mean age rising year after year and a peculiar demographic pyramid.

The catchment area of the HDs represents a key organizational variable of the HDs. The median population of Italian HD is 80,410 (IQR: 51,968-124,132 inhabitants), while DM 77 reform suggests a catchment area of 100,000 inhabitants to standardise the characteristics of the HDs nationwide and to give input

Fig. 1. Number of HDs in Italian regions, divided into Central Poles (A + B); Intermediate Areas (C + D); Peripheral Zones (E + F).



Tab. III. Student's t test on old-age dependency ratio comparing HDs smaller than 100,000 persons to those bigger.

Variables	HDs' mean population ≤ 100,000	HDs' mean population > 100,000	p-value
Old-age dependency ratio	58.18	57.49	< 0.001

Tab. IV. Mann-Whitney U test on geographical and socio-demographic variables comparing HDs with less than 100,000 inhabitants to those with more.

Variables	HDs' median population ≤ 100,000	HDs' median population > 100,000	p-value
Number of Municipalities per HD	8	11.5	0.001
Land area in square kilometres	394.6	542.2	0.003
Population density	133	332.5	< 0.001
Mean age	46.2	46.1	0.552
Ageing index	196	187	0.056
Birth rate index	6.7	6.7	0.553
Mortality index	12.3	12	0.249

to Regions to uniformly implement PHC services. The study emphasizes the need of a defined catchment area and challenges the adequacy of the standards proposed by DM77: in order to better govern and manage the processes and health performance of the HDs (as well as for future analysis) a defined catchment area might not be enough to organize community health services [16].

Considering socio-economic aspects we decided to investigate the old-age dependency ratio: this index correlates to the economic inactivity of the population and it is an important variable to take into account at the governance level of services. The group of HDs with ≤ 100,000 inhabitants has a lower old-age dependency ratio (shown in Tab. III) than the other group. At the same time, the number of municipalities and population density as well as land area per HDs are higher for the HDs with > 100,000 inhabitants, whereas we find no statistical differences in mean age, ageing

Tab. V. One way ANOVA on old-age dependency ratio by IAS score groupings.

Variable	Mean of Central HDs	Mean of Intermediate HDs	Mean of Peripheral HDs	p-value
Old-age dependency ratio	57.63	57.73	58.82	0.117

Tab. VI. Kruskal-Wallis test on continuous variables by IAS score groupings.

Variables	Median of Central HDs	Median of Intermediate HDs	Median of Peripheral HDs	p-value
Number of municipalities in the HD	1	10	10	< 0.001
Population	132,988.5	86,327.5	42,297	< 0.001
Surface area in square kilometres	66	438.8	665.3	< 0.001
Population density	2,665.1	204.2	59.4	< 0.001
Mean age	46.1	46.1	46.8	0.038
Ageing index	178.4	189	217.9	< 0.001
Birth rate index	6.7	6.7	6.4	0.040
Death rate index	11.6	12.2	12.6	0.086

Tab. VII. Post-hoc test with Bonferroni correction on categorical variables.

IAS of the HDs	Number of Municipalities	Population	Surface area	Population density	Mean age	Ageing Index	Birth rate index
HDs of Central Poles *vs* HDs of Intermediate Areas	0	< 0.001	0	0	0.961	0.512	0.137
HDs of Central Poles *vs* HDs of Peripheral Areas	0	0	0	0	0.060	< 0.001	0.015
HDs of Intermediate Areas *vs* HDs of Peripheral Areas	0.994	0	< 0.001	0	0.013	< 0.001	0.074

index, birth rate index and mortality index between HDs with more and less than 100,000 inhabitants (shown in Tab. IV), demonstrating the homogeneous distribution of population between the Italian HDs.

The capillarity of the demographic analysis reaches the district level, in a manner similar to the ISTUD report [4], but adds various demographic indicators, from population size to territorial extension of the HDs, making it possible to observe some macro-phenomena characterising the Italian context.

Considering geographical aspects, in literature a possible difference between urban and mountain territories on PHC services availability was reported [7, 17]. In order to evaluate the impact of geographic characteristics on the population's health needs and the organisational setting of the HDs, we categorised the HDs into Central, Intermediate and Peripheral. Although there is a wide inter-district and inter-regional variability, the prevailing IAS is urban and only 49 HDs (9%) fall under the definition of Peripheral HD (shown in Tab. VI). Thus, it is possible to distinguish Regions whose territories are often mainly central or peripheral, so the Regional strategies might take into account this aspect. It may become topical again to debate whether there should be "Districts" shaped differently according to geographic location and population density since the expression of Public Health finds justification also with respect to these parameters [7].

Through the National Strategy for Inland Areas, we defined an operational way to identify territories very peripheral or distant to urbanised centres with an integrated supply of essential services. Thus, it is paramount not to forget this aspect when defining HD organisation and standardisation. In fact, we showed that when grouping the HDs following inhabitants criteria (more or less than median 100.000 inhabitants) (shown in Tab. IV) the demographic indexes (mean age, the Ageing index, the Birth rate index and the Mortality index) are homogeneous, but when considering the IAS data (shown in Tab. VI) the same indexes indicate the heterogeneity of the HDs. Among other variables, we found a higher mean age of the population and a higher ageing index in the Peripheral HDs, than in the Intermediate and Central ones. In Peripheral HDs there is lower population density, but more elders, often meaning more frailty and vulnerability [18] focused in some areas, needing dedicated social and health services. This work represents the first study in Italy that shows structural differences between HDs. In fact, the greater the level of peripherality of territories with respect to cities and big centres, the more complex the use of services and the worse the quality of life can be. It is possible to distinguish Regions whose territories are often mainly central or peripheral (shown in Fig. 1), so the Regional strategies could take into account this aspect.

Furthermore, our proposal of stratifying Italian HDs into homogeneous groups, according to conditions that influence the health management and population

size, collecting similar municipalities regarding common factors in health management, might allow the identification of comparable groups of HDs, setting up a consistent alternative to performance evaluation studies. The authors believe the Inner Areas Score developed can add an innovative contribution to scientific literature on the topic.

There are some limitations to this study. Since in Italy there is no database regarding the number and size of HDs, as well as the municipality included in each HD, this part of data collection was conducted with hand searching and manually retrieving information from Regional or local websites. So, it is possible that they may not have been updated in a timely manner, just as it is possible that the number may have changed in the meantime. Moreover, our study did not analyse the organisational and legislative choices of Italian Regions even though it would be important to an in-depth study of Regional Laws for a more accurate phenomenon comprehension.

Conclusions

The research showed profound heterogeneity of HDs according to geographic, demographic and socio-economic parameters. HDs are responsible for the multi-sectoral integration of Public Health and PHC, and the finding that there are structural and statistically significant differences between HDs has important consequences in terms of management and implications that policymakers must take note of in policy development.

The ongoing reform [5] of territorial assistance in Italy fits into this scenario and aims at standardisation and homogenization of territorial care. From the data shown, it is difficult to imagine that a standardisation process could meet the needs of such heterogeneous territories without taking into account the demographical, geographical and socio-economic parameters of every HD.

In conclusion, since the population data cannot be the only variable to take into account for the definition of Italian HDs organisation and PNRR reorganisation, we provided a system of intercorrelated variables that take into account geographic location, demographic data, and other aspects, which is reliable and easy to use.

Further investigation will be necessary to assess the level of applicability and enforceability of the established standards and deepen the investigation of other socio-economic indexes.

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Conflict of interest statement

All authors report no conflicts of interest relevant to this article.

Authors' contributions

EG, IS, ARC, AC, AT, ES, SF, GS: conceptualization. EG, IS, ARC, AC, ES, SF, GS: data curation. ARC: formal analysis. IS, ARC, AC, GP: methodology. EG, ARC, ES, GP: resources. EG, IS, ARC, AC, MDP, AT, GP: writing original draft. EG, IS, ARC, AC, MDP, ES, GS: writing review and editing.

References

[1] Italian Law n. 833/1978, Art. 10. Available at: https://www.gazzettaufficiale.it/eli/id/1978/12/28/078U0833/sg (Accessed on: 21/02/2024).

[2] D.Lgs 502/1992, 517/1993, 229/1999. Availabe at: https://www.gazzettaufficiale.it/eli/id/1994/01/07/094A0049/sg (Accessed on: 21/02/2024).

[3] Legge Costituzionale n. 3/2001. Available at: https://www.parlamento.it/parlam/leggi/01003lc.htm#:~:text=%2D%20La%20Regione%20non%20può%20istituire,qualunque%20parte%20del%20territorio%20nazionale (Accessed on: 21/02/2024).

[4] Fondazione ISTUD. Le cure primarie in Italia: verso quali orizzonti di cura ed assistenza. Report 2013. Available at: https://www.quotidianosanita.it/allegati/allegato4056763.pdf (Accessed on: 21/02/2024).

[5] Ministero della Salute. Decreto 23 maggio 2022 n. 77. Regolamento recante la definizione di modelli e standard per lo sviluppo dell'assistenza territoriale nel Servizio sanitario nazionale. Gazzetta Ufficiale - Serie Generale 2022 n. 144 del 22 giugno 2022. Available at: https://www.gazzettaufficiale.it/eli/id/2022/06/22/22G00085/sg (Accessed on: 21/02/2024).

[6] Ricciardi W, Tarricone R. The evolution of the Italian National Health Service. Lancet 2021:S0140-6736(21)01733-5. https://doi.org/10.1016/S0140-6736(21)01733-5.

[7] La rete dei Distretti sanitari in Italia. I quaderni di monitor. 8° supplemento al numero 27 del 2011 di Monitor. AgeNaS Roma. 2011. Available at: https://www.agenas.gov.it/images/agenas/monitor/quaderno/pdf/10_La_rete_dei_Distretti_sanitari_in_Italia.pdf (Accessed on: 21/02/2024).

[8] Agenzia per la Coesione Territoriale. Strategia Nazionle Aree Interne. Available at: https://www.agenziacoesione.gov.it/strategia-nazionale-aree-interne/ (Accessed on: 21/02/2024).

[9] Agenzia per la Coesione territoriale. Guida agli indicatori della "Diagnosi Aperta" della strategia per le aree interne. Available at: https://www.agenziacoesione.gov.it/wp-content/uploads/2021/01/guida_allxinterpretazione_degli_indicatori_per_la_diagnosi_aperta.pdf (Accessed on: 21/02/2024).

[10] ISTAT. Popolazione residente 1° gennaio. Available at: http://dati.istat.it/Index.aspx?DataSetCode=DCIS_POPRES1# (Accessed on: 21/02/2024).

[11] ISTAT. Indicatori Demografici | anno 2021. Available at: https://www.istat.it/it/files/2022/04/Report-Indicatori-Demografici_2021.pdf (Accessed on: 21/02/2024).

[12] ISTAT. Demographic Indicators. Available at: http://dati.istat.it/Index.aspx?DataSetCode=DCIS_INDDEMOG1&Lang=en (Accessed on: 21/02/2024).

[13] Cummins S, Curtis S, Diez-Roux AV, Macintyre S. Understanding and representing 'place' in health research: a relational approach. Soc Sci Med 2007;65:1825-38. https://doi.org/10.1016/j.socscimed.2007.05.036.

[14] Macintyre S, Ellaway A, Cummins S. Place effects on health: how can we conceptualise, operationalise and measure them? Soc Sci Med 2002;55:125-39. https://doi.org/10.1016/s0277-9536(01)00214-3.

[15] ISTAT. Censimenti permanenti popolazione e abitazioni. Popolazione residente e dinamica demografica. 2021. Available at:

https://www.istat.it/it/files/2022/12/CENSIMENTO-E-DINAMICA-DEMOGRAFICA-2021.pdf (Accessed on: 21/02/2024).

[16] Marino Calvo MC, Telino de Lacerda J, Flemming Colussi C, Ceola Schneider IJ, Hernandes Rocha TA. Estratificação de municípios brasileiros para avaliação de desempenho em saúde. Epidemiol Serv Saúde 2016;25(4). https://doi.org/10.5123/S1679-49742016000400010.

[17] Samarasundera E, Walsh T, Cheng T, Koenig A, Jattansingh K, Dawe A, Soljak M. Methods and tools for geographical mapping and analysis in primary health care. Prim Health Care Res Dev 2012;13:10-21. https://doi.org/10.1017/S1463423611000417.

[18] Aceti T, Del Bufalo P, Nardi S, Ruggieri MP. Il Piano Nazionale della Cronicità per l'equità 6° Report. Salutequità, 16 novembre 2022. Available at: http://salutequita.it/wp-content/uploads/2021/11/Report-Cronicità-definitivo-C.pdf (Accessed on: 21/02/2024).

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Occupation Medicine and Hygiene

Cardiovascular disorders and exposure to chemical pollutants

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Keywords

Cardiovascular disorders • Occupational disease • Risk factors • Chemical hazards • Exposure

Summary

Introduction. *Exposure with some chemical can cause cardiovascular disorders. Occupational exposures with chemicals are modifiable risk factors for cardiovascular diseases. The Objective of this study was the determination of cardiovascular disorders in industries with occupational exposures.*
Materials and methods. *Study was a cross-sectional method and was done on workers of related industries. The study was done with a physical examination and checklist by getting health and illness history and clinical tests about the risk factors and cardiovascular disorders. According to exposures the population of the study was divided into 3 groups. Data were analyzed with SPSS 16, by considering $p < 0.05$ as significant.*
Results. *The frequency of unstable angina and stable angina were the most in group 1. The relative risk for unstable angina was 1.55 (1.46-1.61) in group 1 and for stable angina was 1.54 (1.47-1.62) in this group. The risk of thrombophlebitis was 8.48 (7.07-10.17) in group 2.*
Conclusions. *Workers in industry with chemical pollutants had cardiovascular disorders. The occupational exposures, especially chemical agents are effective on cardiovascular system.*

Introduction

Cardiovascular disorders have been the most causes of death in the world in recent decades. At least 52 percent of deaths were from noncommunicable diseases (NCDs). The most frequent NCDs were cardiovascular disorders (CVDs) near 37 percent [1].
CVDs are known disorders that more than 30 percent of people in the community are affected and many of them have its complications and disabilities. These disorders have many important risk factors; changeable and non changeable risks [2]. Some of the changeable risks are hyperlipidemias; high levels of low-density lipoprotein (LDL) and triglyceride (TG), smoking, nutrition, overweight and obesity, hypertension, environmental and occupational exposures [3, 4].
Occupations have many hazards for the cardiovascular system. These items could be modified. These hazards are chemical such as metals; Lead (Pb), Cadmium (Cd), Antimony(Sb), Arsenic (As), other chemicals, solvents, particulate matters and gases, physical and psychological stress [3, 4].
The lead could be caused hypertension with a direct effect on the vascular system and with an indirect effect with chronic renal disorder. Cadmium might be affected on blood pressure and hypertension, it is related to renal effects of Cadmium especially. Arsenic could be caused gangrene by vessel injuries. Arsenic and Antimony could be caused arrhythmias and electrocardiography disturbances. Carbon disulfide had effects on blood vessels. The noise could be as a stressor factor for high blood pressure.
Scientists demonstrated the occupational risk of ischemic heart disease, in this study was shown the effect of Lead as a toxic metal in the cardiovascular system [5]. In a prospective cohort study, researchers showed the effect of metal welding fume on cardiovascular disease [6].
Researchers studied the association between blood Lead and blood pressure [7]. Scientists researched the prevalence of major cardiovascular risk factors among oil and gas and energy company workers [8].
Researchers demonstrated the effect of exposure limits for oil-based metalworking fluids on cardiovascular mortality in a cohort of autoworkers [9].
There were some studies that worked on other occupational risks. Scientists showed diminished health status in firefighters [10].
Researchers worked on occupational noise and myocardial infarction [11]. One study showed the effect of low-dose ionizing radiation on cardiovascular diseases [12]. Other researchers studied and found the same results in this situation [13-16].
Researchers demonstrated the influence of the cardiomyocyte circadian clock on cardiac physiology and pathophysiology [17]. There were some studies about night-shift work and its effect on the cardiovascular system and causing disorders [18-20]. These studies emphasized on circadian rhythm disturbances that can cause physiological disruption in the circular system [21-23]. Kind of job and occupational risks, researched in other study health care workers, car industry and others, the result was important and specific [24, 25].
In some job, psychological stress was more important than other risks [26-29]. Preventive methods

for cardiovascular health were emphasized and introduced [30, 31]. The workers must be helped to the health system for having better health [32].
There were none modifiable risks such as age and gender [33]. We cannot work on. In the world, there were a lot of useful studies on cardiovascular health [34, 35]. The prevalence and incidence of CVDs were different in the world. In countries with low to middle income, cardiovascular disorders were more prevalent [36, 37].
Researchers had some studies about the occupational risk factors in some industries [38-41].
Objective of this study was the determination of cardiovascular disorders in industries with occupational exposures.

Methods

Study setting

Industries with exposure to chemical pollutants (municipality; city services and related jobs) in Mashhad; northeast of Iran.

Study design and target population

The study was a cross-sectional method, was done on workers who were employed in related industries, about cardiovascular disorders and risk factors. The data were taken from personnel with a physical examination and a filling checklist by getting health and illness history, study of risk factors for cardiovascular disorders. According to exposures the population of the study was divided into 3 groups.
According to this 3 groups were demonstrated in industries: group 1; workers at exposure to chemical pollutants (face worker) 988 person, male workers, 35.56 ys, group 2; other workers without exposures in the same industry specially sedentary works (nonexposure) 987 person, male workers, 34.25 ys, group 3; other workers with low level physical and chemical hazards at the same industry(nonface worker) 989 person, male workers, 36.54 ys.
The study populations were workers from the industries with exposure to chemicals. The author researched and followed by a physical examination in research time. Random sampling method was used to $\alpha = 0.05$, power = 80, P1 = 34% and P2 = 14%, study population were calculated 988 for each group (3 groups). About 2,964 in total were assessed.

The inclusion and exclusion criteria

Inclusion criteria were workers who worked in an industry with chemical pollutants, other workers without chemicals and other workers with low level, at least one year of work experience in the same work. The exclusion criteria were having cardiovascular disorders and related diseases before beginning this job.

Procedure

Participants were evaluated for risk factors for cardiovascular disorders: overweight and obesity (BMI 25 and more than 25), smoking (1 pack year and more), age (45s and more than 45s), diet (salty, high lipid, low fiber), stress (environmental and occupational), family history(cardiovascular disorders related disorders and death from them), hyper low density lipoprotein (LDL > 100 mg/dl), hyper triglyceride (TG > 200 mg/dl) and hypertension (systolic blood pressure 130 mmHg and more and diastolic blood pressure 80 mmHg and more).
In checklist design of the study; the checklist was checked with clinicians and specialists and also an experimental study was done with relation to 92.5%. The author interviewed by using a checklist and done tests in the clinical place with use of health issues in occupational health center.
Exposure assessment; for exposure assessment in this study physical hazards: noise and chemical hazards: toxic metal; lead, particulate matter, carbon monoxide, solvent had been assessed and the risk was calculated.
They had the same rotating shift work. Occupational exposures were measured and assessed. Sites 1 had metal exposures, particulate matter and carbon monoxide more than recommended exposure limits [42]. But it was less than the permissible exposure limits. The noise was measured with a sound level meter. Metal had been measured with occupation and toxicological standards. Environmental Lead and particulate matter had been measured with air sampling collected and filters dissolve with acids and the analytical methods with atomic absorption spectroscopy (AAS) were done. In clinical toxicology, blood samples had been examined for Lead, red blood cells were hemolyzed and blood ingested with acids then analyzed by atomic absorption spectroscopy and carboxihemoglobin had been examined after addition of acids then analyzed by atomic absorption spectroscopy. Air sample had been collected for measuring carbon monoxide analyzed with gas chromatography (GC) had been analyzed [42].

Statistical analysis

Data were analyzed with SPSS, statistical tests; kolmogorov smirnov test was used for assessment of quantitative variables normality then paramtric test; ANOVA test was done. Chi-2 or Exact test were used to compare qualitative variables and relative risks were measured according to confidence interval 95%. A p-value of less than 0.05 was measured for significant levels. Regression logistic was used for elimination of some related variables effects.

Etical consideration

In ethical consideration; this study was done with ethical attention and Helsinki declaration and participants' consent.

Results

General results

According to exposures, in this study, participants were divided into 3 groups. The mean age of the population was 35.62 ± 5.64 years old. The mean of work duration was 9.05 ± 4.60 years at the beginning of the study. The mean body mass index (BMI) was 25.56 ± 2.29 kg/m^2.

Special results

Result of mean exposure assessment in site 1: Lead in air was 0.03mg/m^3, (Blood Lead level was 25 mg/dL), particulate matter 2.5 was 0. 1 mg/m^3, carbon monoxide was 5 ppm (carboxihemoglobin was 3 percent). In site 2: none exposure and in site 3: noise was 75 dBA and particulate matter 2.5 in the air was 0.01 mg/m^3, carbon monoxide was 1 ppm, others were zero.

Table I shows the comparison between frequencies of cardiovascular disorders risks factors in three groups ($p < 0.05$). Hyper low-density lipoprotein (LDL > 100 mg/dl), hyper triglyceride (TG > 200 mg/dl), positive family history, rhythm disorders was the most in group 1 but had no significant differences. Smoking and overweight and obesity were the most in group 1and had significant differences ($p < 0.05$).

Table II demonstrates a comparison between frequencies of cardiovascular disorders in three groups ($p < 0.05$). Unstable angina and stable angina were the most in group 1 with significant differences. Myocardial infarction and varicose veins were the most in group 1, no significant differences ($p < 0.05$).

Table III shows the relative risks of cardiovascular disorders in three groups. The risk of thrombophlebitis was the most with 8.48 (7.07-10.17) in group 2 and 2.87 (2.62-3.14) in group 1. Hypertension had the most relative risk in group 1 with 2.14 (1.02-4.46). In three groups the relative risks were more than 1 but after the elimination of smoking and overweight affects the risk of hypertension was significantly in group 1 and in other groups relative risks were not significant.

Discussion

Also, according to study results, the number of workers

Tab. I. Comparison between frequencies of cardiovascular disorders risk factors in three groups ($p < 0.05$).

Groups / Risk factors	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Chi-2 or Exact test	p-value
LDL > 100 mg/dl	226 (22.6)	44 (4.4)	29 (2.9)	0.451	0.798
TG > 200 mg/dl	443 (44.3)	83 (8.3)	171 (17.1)	4.963	0.084
Hypertension	540 (54.0)	101 (10.1)	198 (19.8)	5.8080	0.007
Positive Family history	3 (0. 3)	1 (0. 1)	1 (0. 1)	1.611	0.447
History of related disorder	2 (0. 2)	1 (0. 1)	1 (0. 1)	0.536	0.765
Smoking	76 (7.6)	11 (1.1)	1 (0.1)	29.55	< 0.001
Over weight	189 (18.9)	63 (6.3)	1 (0.1)	6.406	0.024

Tab. II. Comparison between frequencies of cardiovascular disorders in three groups ($p < 0.05$).

Groups / Disorders	Group 1 N (%)	Group 2 N (%)	Group 3 N (%)	Chi-2 or Exact test	p-value
Myocardial infarction	1 (0.1)	0	0	0.536	0.765
Unstable angina	5 (0.5)	1 (0.1)	1 (0.1)	2.691	0.03
Stable angina	13 (1.3)	1 (0.1)	3 (0.3)	7.061	0.004
Thrombophlebitis	1 (0.1)	2 (0.2)	0	7.422	0.119
Varicose veins	3 (0.3)	1 (0.1)	2 (0.2)	1.611	0.276
Rhythm disorders	2 (0. 2)	1 (0. 1)	1 (0. 1)	0.544	0.754
Chronic heart failure	1(0.1)	0	0	0.536	0.765

Tab. III. Relative risks with confidence intervals and after the elimination of overweight and smoking effects in three groups.

Diseases	Group 1 RR(CI)	Group 2 RR(CI)	Group 3 RR(CI)
Hypertension	2.14 (1.02-4.46)	1.00 (0.99-1.01)	1.02 (0.97-1.01)
Myocardial infarction	1.53 (1.46-1.61)	-	-
Unstable angina	1.54 (1.46-1.61)	1.13 (1.10-1.16)	1.30 (1.25-1.34)
Stable angina	1.54 (1.47-1.62)	1.14 (1.11-1.17)	1.30 (1.25-1.34)
Thrombophlebitis	2.87 (2.62-3.14)	8.48 (7.07-10.17)	
Varicose veins	1.53 (1.46-1.61)	1.13 (1.10-1.16)	1.30 (1.25-1.35)
Chronic heart failure	1.52 (1.45-1.60)	-	-

with cardiovascular disorders was the most in group 1 with 54 percent after 10 years. There was 19.8 percent in group 3 and 10.1 percent in group 2.

In this study, the number of workers with hypertension, unstable angina, and stable angina was the most in group 1 with significant level $p < 0.05$. Another study showed that ischemic heart disease in workers exposed to metal fumes and particles [5].

Another study had been found the results from exposure to metal welding fume related to cardiovascular disease [6]. In this study, we saw the most number of hypertension in group 1 that exposed to chemicals. In this study in site 1; Lead, particulate matter 2.5 and carbon monoxide were more than others. In another study demonstrated the metal effects on the incidence of hypertension too [7].

Oil and gas and energy company workers, oil-based metalworking fluids workers and in firefighters, studies showed the chemical effects on the cardiovascular system [8-10].

In this study after the elimination of smoking and overweight effects, there was some risk for cardiovascular disorders such as hypertension, unstable angina, and stable angina.

Group 2 with sedentary work was sensitive to thrombophlebitis disorders. In other studies, the risk of cardiovascular attacks and morbidity were demonstrated [5, 9].

Unfortunately in this study were not a psychological assessment that other studies found its effects on cardiovascular disorders [27, 28]. In this study, they had the same rotating shift work and the same nutritionally. Other studies showed the effect of night shift work and unsuitable nutrition on the cardiovascular system [22, 23].

The number of hyper low-density lipoprotein and hyper triglyceride were the most in group 1 that were not significant. It recommended that having a better nutrition and exercise program for workers. In other studies were recommended the preventive methods for health and wellbeing [30, 31]. Overweight and obese people were the most in group 1 and smoking too. There were two risk factors, after the elimination their effects we saw the risks of cardiovascular disorders too. In other studies, the researcher showed the effect of these risks [30, 31].

Physical risks had effective in cardiovascular system disorders in some studies were shown, according to scientific literature, not all physicals, but noise, coldness, and vibration were more prominent in this case [13-15]. In exposure to chemicals and physicals this fact was more prominent [14]. In this study the group 1 exposed to metal, particles and gas, group 2 had not physical and chemical and group 3 has a low level of both of them.

In this study, the author tries to isolate the three groups with special hazards, but workers in group 3 might be exposed to some physicals and chemicals, that these results might be related to occupational exposures. In this study, the author could not done the exact job analysis that other study with better isolation of groups can be more useful. The researcher did not complete an assessment about psychological stress, This item can be affected by cardiovascular system health.

According to this Study, researchers said that job analysis and determination of occupational risk factors for different industries, especially with metal agents and particulate matters exposure were necessary.

The author found that the work in the related industry had a risk of cardiovascular disorders. The chemical hazards in high exposure was more effective in the cardiovascular system.

Although the chemicals could be the most effective occupational hazards for cardiovascular disorders, especially heart attacks and angina, however other risks should not forget. Control of nonoccupational risk factors was necessary too.

Conclusions

Workers in industry with chemical pollutants had cardiovascular disorders. The occupational exposures, especially chemical agents are effective on cardiovascular system:

1. unstable angina and stable angina were more in exposure to chemicals than others;
2. thrombophlebitis was more in sedentary works than others;
3. author recommended control of chemical exposures for prevention of stable and unstable angina;
4. author recommended periodic exercises in sedentary works for prevention of thrombophlebitis

Preventive methods were useful and effective in this situation. Control of nonoccupational risk factors mustbe done too.

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Etical consideration

Compliance with ethical guidelines

In ethical consideration; this study was done with ethical attention and Helsinki declaration and participants' consent.

Conflict of interest statement

Author had not any personal financial interests.

Authors' contributions

SNA: researched and wrote the article.

References

[1] World Health Organization. Global status report on non communicable diseases report. Available at: https://www.who.int (Accessed on: 04/03/2021).

[2] World Heart Federation. Risk factors. Available at: https://www.world-heart-federation.org/resources/risk-factors (Accessed on: 06/02/2021).

[3] Price A.E,Petch M.C, Cardiovascular disorders. In: Palmer KT, Cox RAF, Brown I, eds. Fitness for work The medical aspects. London: The Oxford university press 2007, pp. 381-400.

[4] Rosenman K.D, Occupational heart disease, In: Rom WN, ed. Environmental and Occupational Medicine. New York: The Lippincott Williams and Wilkins 2007, pp. 681-93.

[5] CDC. Lead, health problems caused by lead. Available at: http://www.cdc.gov/niosh (Accessed on: 02/01/2021).

[6] Ibfelt E, Bonde JP, Hansen J. Exposure to metal welding fume particles and risk for cardiovascular disease in Denmark: a prospective cohort study. Occup Environ Med 2010;67:772-77. https://doi.org/10.1136/oem.2009.051086.

[7] Bushnik T, Levallois P, D'Amour M, Anderson TJ, McAlister FA, Association between blood lead and blood pressure: Results from the Canadian Health Measures Survey(2007 to 2011). Health Rep 2014;25:12-22.

[8] Mannocci A, Pignalosa S, Saulle R, Sernia S, De Sanctis S, Consentino M, Gialdi C, Nicosia V, La Torre G.Prevalence of major cardiovascular risk factors among oil and gas and energy company workers. Ann Ist Super Sanita 2015;51:148-53. https://doi.org/10.4415/ANN_15_02_13.

[9] Picciotto S, Peters A, Eisen EA. Hypothetical exposure limits for oil-based metalworking fluids and cardiovascular mortality in a cohort of autoworkers: structural accelerated failure time models in a public health framework. Am J Epidemiol 2015;181:563-70. https://doi.org/10.1093/aje/kwu484.

[10] Plat MJ, Frings-Dresen MH, Sluiter JK. Diminished health status in firefighters. Ergonomics 2012;55:1119-22. https://doi.org/10.1080/00140139.2012.697581.

[11] Kersten N, Backé E. Occupational noise and myocardial infarction: considerations on the interrelation of noise with job demands. Noise Health 2015;17:116-22. https://doi.org/10.4103/1463-1741.153403.

[12] Kreuzer M, Auvinen A, Cardis E, Hall J, Jourdain JR, Laurier D, Little MP, Peters A, Raj K, Russell NS, Tapio S, Zhang W, Gomolka M. Low-dose ionizing radiation and cardiovascular diseases - Strategies for molecular epidemiological studies in Europe. Mutat Res Rev Mutat Res 2015;764:90-100. https://doi.org/10.1016/j.mrrev.2015.03.002.

[13] Assunta C, Ilaria S, Simone de S, Gianfranco T, Teodorico C, Carmina S, Anastasia S, Roberto G, Francesco T, Valeria RM. Noise and cardiovascular effects in workers of the sanitary fixtures industry. Int J Hyg Environ Health 2015;218:163-68. https://doi.org/10.1016/j.ijheh.2014.09.007.

[14] Foraster M, Künzli N, Aguilera I, Rivera M, Agis D, Vila J. Bouso L, Deltell A, Marrugat J, Ramos R, Sunyer J, Elosua R, Basagaña X. High Blood Pressure and Long-Term Exposure to Indoor Noise and Air Pollution from Road Traffic. Environ Health Perspect 2014;122:1193-200. https://doi.org/10.1289/ehp.1307156.

[15] Tuo B, Li C, Peng L, Ye M, Liu W, Zhong X, Li H. Analysis of differentially expressed genes in cold-exposed mice to investigate the potential causes of cold-induced hypertension. Exp Ther Med 2014;8:110-4. https://doi.org/10.3892/etm.2014.1703.

[16] Koskinen HL, Kauppinen T, Tenkanen L. Dual role of physical workload and occupational noise in the association of the metabolic syndrome with the risk of coronary heart disease: findings from the Helsinki Heart Study. Occup Environ Med 2011;68:666-73. https://doi.org/10.1136/oem.2010.057075.

[17] Martino TA, Young ME. Influence of the Cardiomyocyte Circadian Clock on Cardiac Physiology and Pathophysiology. J Biol Rhythms 2015;30:183-205. https://doi.org/10.1177/0748730415575246.

[18] Alibhai FJ, Tsimakouridze EV, Reitz CJ, Pyle WG, Martino TA. Consequences of Circadian and Sleep Disturbances for the Cardiovascular System. Can J Cardiol 2015;31:860-72. https://doi.org/10.1016/j.cjca.2015.01.015.

[19] Park S, Nam J, Lee JK, Oh SS, Kang HT, Koh SB. Association between night work and cardiovascular diseases: analysis of the 3rd Korean working conditions survey. Ann Occup Environ Med 2015;27:15. https://doi.org/10.1186/s40557-015-0064-1.

[20] Silva-Costa A, Griep RH, Rotenberg L. Disentangling the effects of insomnia and night work on cardiovascular diseases: a study in nursing professionals. Braz J Med Biol Res 2015;48:120-7. https://doi.org/10.1590/1414-431X20143965.

[21] Lajoie P, Aronson KJ, Day A, Tranmer J. A cross-sectional study of shift work, sleep quality and cardiometabolic risk in female hospital employees. BMJ Open 2015;5:e007327. https://doi.org/10.1136/bmjopen-2014-007327.

[22] Yong M, Germann C, Lang S, Oberlinner C Primary selection into shift work and change of cardiovascular risk profile. Scand J Work Environ Health. 2015 1;41(3):259-67. https://doi.org/10.5271/sjweh.3487. Epub 2015 Feb 20.

[23] Pimenta AM, Kac G, Souza RR, Ferreira LM, Siqueira SM, Night-shift work and cardiovascular risk among employees of a public university. Rev Assoc Med Bras 2012;58:168-77. https://pubmed.ncbi.nlm.nih.gov/22569611/.

[24] Juárez-Pérez CA, Aguilar-Madrid G, Haro-García LC, Gopher-Nieto R, Cabello-López A, Jiménez-Ramírez C, Aguado A, Martínez-Méndez LM, Chávez-Negrete A. Increased Cardiovascular Risk Using Atherogenic Index Measurement Among Healthcare Workers. Arch Med Res 2015;46:233-39. https://doi.org/10.1016/j.arcmed.2015.03.002.

[25] Ohlander J, Keskin MC, Stork J, Radon K. Shift work and hypertension: Prevalence and analysis of disease pathways in a German car manufacturing company. Am J Ind Med 2015;58:549-60. https://doi.org/10.1002/ajim.22437.

[26] Mirmohammadi SJ, Taheri M, Mehrparvar AH, Heydari M, Saadati Kanafi A, Mostaghaci M. Occupational stress and cardiovascular risk factors in high-ranking government officials and office workers. Iran Red Crescent Med J 2014;16:e11747. https://doi.org/10.5812/ircmj.11747.

[27] Maeda E, Iwata T, Murata K. Effects of work stress and home stress on autonomic nervous function in Japanese male workers. Ind Health 2015;53:132-38. https://doi.org/10.2486/indhealth.2014-0157.

[28] Babu GR, Jotheeswaran AT, Mahapatra T, Mahapatra S, Kumar A Sr, Detels R. Is hypertension associated with job strain? A meta-analysis of observational Studies. Postgrad Med J 2014;90:402-9. https://doi.org/10.1136/postgradmedj-2013-101396rep.

[29] Babu GR, Mahapatra T, Detels R. Job stress and hypertension in younger software professionals in India. Indian J Occup Environ Med 2013;17:101-7. https://doi.org/10.4103/0019-5278.130848.

[30] Kruk ME, Nigenda G, Knaul FM. Redesigning primary care to tackle the global epidemic of noncommunicable disease. Am J Public Health 2015;105:431-37. https://doi.org/10.2105/AJPH.2014.302392.

[31] Polvinen A, Laaksonen M, Gould R, Lahelma E, Leinonen T, Martikainen P. Socioeconomic inequalities in cause-specific mortality after disability retirement due to different dis-

eases. Scand J Public Health 2015;43:159-68. https://doi.org/10.1177/1403494814562597.

[32] Gao J, Liang X, Shi J, Huang Z, Wei X, Li H, Lin L, Xing A, Du X, Wu S. Impact of ideal cardiovascular health behaviors and factors on resting heart rate in individuals without cardiovascular diseases. Zhonghua Xin Xue Guan Bing Za Zhi 2014;42:778-83. https://pubmed.ncbi.nlm.nih.gov/25511100.

[33] López-González ÁA, Bennasar-Veny M, Tauler P, Aguilo A, Tomàs-Salvà M, Yáñez A. Socioeconomic inequalities and age and gender differences in cardiovascular risk factors. Gac Sanit 2015;29:27-36. https://doi.org/10.1016/j.gaceta.2014.08.004.

[34] Tao J, Li D, Dong Y, Wu S.Relationship between resting heart rate and brachial-ankle pulse wave velocity in a healthy Chinese population. Zhonghua Xin Xue Guan Bing Za Zhi 2014;42:686-92. https://pubmed.ncbi.nlm.nih.gov/25388344/.

[35] Akintunde AA, Salawu AA, Opadijo OG. Prevalence of traditional cardiovascular risk factors among the staff of Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Niger J Clin Pract 2014;17:750-55. https://doi.org/10.4103/1119-3077.144390.

[36] Jagannathan R, Nanditha A, Sundaram S, Simon M, Shetty AS, Snehalatha C, Johnston DG, Ramachandran A. Screening among male industrial workers in India shows a high prevalence of impaired glucose tolerance, undetected diabetes, and cardiovascular risk clustering. J Assoc Physicians India 2014;62:312-15.

[37] Ogedegbe G, Gyamfi J, Plange-Rhule J, Surkis A, Rosenthal DM, Airhihenbuwa C, Iwelunmor J, Cooper R. Task shifting interventions for cardiovascular risk reduction in low-income and middle-income countries: a systematic review of randomized controlled trials. BMJ Open 2014;4:e005983. https://doi.org/10.1136/bmjopen-2014-005983.

[38] Lin CM, Li CY. Prevalence of cardiovascular risk factors in Taiwanese healthcare workers. Ind Health 2009;47:411-8. https://doi.org/10.2486/indhealth.47.411.

[39] Santini A, Caciari T, De Sio S, Fiaschetti M, Di Giorgio V, Samperi I, et al. Cardiovascular diseases in workers at risk. G Ital Med Lav Ergon 2010;32:163-5. https://pubmed.ncbi.nlm.nih.gov/21438249/.

[40] Kang K, Koh SB, Cha BS, Park JK, Baik SK, Chang SJ. Job stress and cardiovascular risk factors in male workers. Prev Med 2005;40:583-8. https://doi.org/10.1016/j.ypmed.2004.07.018.

[41] Rijs KJ, van der Pas S, Geuskens GA, Cozijnsen R, Koppes LL, van der Beek AJ, Deeg DJ. Development and validation of a physical and psychosocial job-exposure matrix in older and retired works. Ann Occup Hyg 2014;58:152-70. https://doi.org/10.1093/annhyg/met052.

[42] National Institute For Occupational Safety and Health. NIOSH Recommended Standards. Available at: https:// www.cdc.gov/niosh (Accessed on: 06/05/2022).

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Occupation Medicine and Hygiene

Dental caries, oral hygiene status and deleterious habits among migrant construction workers of Belagavi, India

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Keywords

Dental caries • Migrant construction worker • Occupational health • Oral health, oral hygiene

Summary

Background. *Occupation significantly influences oral health, with factors like the work environment, stress levels, access to dental care, and job-related habits playing crucial roles. The oral health of construction workers, especially migrant workers, is a noteworthy concern. Understanding the oral health of this population is crucial for enhancing their quality of life through various means. This study aimed to investigate the prevalence of dental caries, oral hygiene status, and deleterious habits in this occupational group of Belagavi district, Karnataka.*
Materials and methods. *Study design was cross-sectional in nature. Before commencement of the study a pilot study was conducted. Multi-stage random sampling technique was employed, and 610 participants were recruited for the study. Trained and calibrated examiners recorded WHO dentition status and treatment needs (2013) and Oral Hygiene Index Simplified (OHI-S). Collected data was analyzed using descriptive analysis, chi-square, one-way ANOVA, and multiple linear regression analysis.*
Results. *The prevalence of dental caries among construction workers was significantly high (81%), and poor oral hygiene was observed among 36.9% of them. The prevalence of smoking, the tobacco chewing habit, and alcohol consumption among the construction workers was found to be 21.6%, 59.9%, and 37.3%, respectively. The dependence of OHI-S and DMFT on predictors (age, gender and deleterious habits) was found to be 21.5% and 39.6%, respectively.*
Conclusions. *Migrant construction workers in Belagavi had a high caries prevalence, poor oral hygiene status, and a high prevalence of deleterious habits such as tobacco use. These results emphasize the necessity of awareness and dental health education programs to improve the oral health of construction workers.*

Introduction

Oral health represents a foundational and integral aspect of an individual's overall well-being, demonstrating an unequivocal and substantial interconnection with an individual's quality of life [1]. The empirical evidence underscores the inextricable relationship between oral health and general health, emphasizing its profound influence on human well-being [2]. Oral diseases stand among the most prevalent non-communicable conditions, affecting diverse populations globally [3]. This evolving pattern of disease incidence is intricately linked to evolving lifestyles characterized by the consumption of high-sugar diets, widespread tobacco usage, and increased alcohol intake. High-sugar diets facilitate the proliferation of deleterious bacteria, contributing to dental caries [4]. Concurrently, tobacco usage is closely associated with heightened risks of periodontal diseases, tooth loss, and oral malignancies [5]. Excessive alcohol intake induces xerostomia, diminishing the salivary protective environment, thereby increasing susceptibility to dental caries [6]. Furthermore, it is imperative to underscore that dental caries is a multifactorial disease, its aetiology influenced by a spectrum of factors.

It is crucial to recognize the substantial impact of occupation on holistic health, encompassing physical, mental, and social well-being [7]. Various occupational factors, such as work hours and levels of job-related stress, exhibit direct associations with overall health outcomes [8]. For instance, specific professions involving extended exposure to sunlight during prolonged work shifts render individuals more vulnerable to dehydration, thereby increasing the susceptibility to dental caries [9]. Construction workers, in particular, exemplify a prime example of this challenging occupational scenario. Previous studies have unveiled a nuanced interconnection among work hours, stress and oral health within the construction workers [10]. It indicates that occupational stress is associated with adverse oral health outcomes, encompassing issues such as dry mouth, temporomandibular disorders, and other oral symptoms [11].
The construction industry holds a significant position in India's economy, serving as the second largest employer, following agriculture. India's economic framework revolves around three primary sectors: agriculture, industry, and services, with the industrial sector being a substantial contributor to the nation's overall income. According to the National Classification of Industry, the construction sector falls under code 5,

while construction workers are categorized under codes 7 and 9 in the National Classification of Occupation. It is worth noting that a substantial majority of the workforce, encompassing approximately 92% or roughly 340 million individuals, operates in the unorganized sector, with nearly half of them affiliated with the construction industry [12]. Unfortunately, health and well-being of these construction workers in this sector often receive inadequate attention within India.

Migrant construction workers, a global phenomenon contributing to the socio-economic development of many countries. With millions of migrant workers worldwide, it's crucial to ensure their well-being, at their workplace [13]. The oral and general health status of construction workers, particularly migrant labourers, stands as a pressing concern. Despite conscientious efforts to ensure worker health and safety, the statistical landscape remains disconcerting. In 2018, the International Labour Organization reported a substantial number of work-related incidents. Annually, there were 374 million documented cases of nonfatal accidents or illnesses in the workplace. Additionally, there were over 2.78 million workplace fatalities recorded [14]. In practical terms, this translates to a work-related accident transpiring every 15 seconds, affecting 150 workers, and culminating in the loss of one worker's life within each such interval [15].

Migrant construction workers, particularly those hailing from isolated villages with limited educational backgrounds and language skills, are notably less informed about preventive measures to safeguard their health [16]. Higher education often correlates with better oral hygiene habits, while language proficiency is crucial for effective communication with healthcare providers, facilitating improved access to dental services [17]. Moreover, the combination of low literacy levels and socio-economic status within this demographic results in a significant prevalence of tobacco use, both in smoking and chewing forms. Furthermore, studies have indicated that migrants exhibit elevated rates of tobacco use in comparison to the general population of their home regions [18]. The situation is further exacerbated by a lack of awareness concerning preventive measures, collectively intensifying the hurdles they encounter.

Despite being a prominent occupation in India, there exists a notable research gap concerning the oral health of this population. The scientific literature lacks an adequate number of studies on the oral health outcomes of this vulnerable population. To address this gap and contribute to the understanding of the unique challenges faced by migrant construction workers, it is essential to investigate oral health concerns within the context of occupational health. The main objectives of this study was to investigate the prevalence of dental caries, oral hygiene status, and deleterious habits among migrant construction workers in the Belagavi district, India.

Materials and methods

Study setting

This study was of a descriptive and cross-sectional design, adhering to the STROBE guidelines for comprehensive reporting. The study was carried out within the demographic of migrant construction workers of the Belagavi district, situated in the state of Karnataka, India, spanning the period from December 2022 to February 2023.

Ethical considerations and informed consent

The study protocol underwent evaluation and ethical approval from the Institutional Ethics and Research Committee. Official permission was secured from relevant construction site authorities before commencing oral examination. Study participants were thoroughly briefed on data acquisition, confidentiality measures, and study objectives, followed by obtaining written informed consent.

Training and calibration

Before the commencement of the study, a panel of experts rigorously standardized and calibrated the examiners to guarantee a consistent approach to the examinations. This process aimed to ensure uniform interpretations of the specific codes and criteria that were to be recorded. Two examiners were involved in the assessment, and the inter-examiner reliability for the World Health Organization (WHO) Oral Health Assessment Form (2013) [19] and Oral Hygiene Index Simplified (OHI-S) [20] was evaluated through Kappa statistics, yielding reliability scores of 88% and 90%, respectively affirming the precision and consistency of the data collection process. A high Cohen's Kappa score indicates a strong level of agreement between the two examiners. This statistical measure takes into account both the presence of agreement and the probability of agreement occurring by chance.

Selection criteria

Construction workers aged 18 years and older were enrolled in the study, and exclusion criteria encompassed those who declined participation or did not provide informed consent for their involvement.

Sample size estimation and sampling technique

A pilot study was conducted among 50 participants to determine the sample size and to assess the feasibility of the study. The findings from the pilot study revealed a disparity in the prevalence of dental caries, with a prevalence of 69.18% among male construction workers and 43.75% among their female counterparts. The minimum sample size was estimated to be 550 with type I (α) error = 0.05 and Power (1-β) = 0.95 using G*Power statistical software (Ver. 3.1.9.4.). Considering 10% attrition the final sample size was rounded off to 610. Participants in this study were recruited by multi-stage

random sampling approach. The geographic area of Belagavi district was subdivided into 15 administrative talukas. Within each taluka, a single construction site was randomly selected. Each chosen construction site constituted around 35-42 migrant construction workers, thereby forming the basis for data collection within this study.

Data collection

The study instrument was designed in alignment with the WHO Oral Health Assessment Form (1997) and comprised three distinct sections: (1) Demographic data, encompassing age and gender, (2) Assessment of deleterious habits prevalent among the construction workers, which included smoking, tobacco chewing, and alcohol consumption, and (3) Evaluation of clinical parameters, specifically DMFT (Decayed Missing Filled Teeth) Index and oral hygiene status (OHI-S).

The examiners carried out the data collection on specified dates at construction sites within the Belagavi district. A total of 610 construction workers, spanning four distinct age groups, underwent a Type III examination. The average examination duration for each subject was approximately 15 minutes and was carried out under natural light.

Statistical analysis

The recorded data were entered in Microsoft Excel 2019 and analysed using IBM-SPSS® Statistics-Version 21 (IBM, USA). Descriptive statistics were computed, which included percentages, means and standard deviations. The normality of the data distribution was determined using the Shapiro-Wilk test. Chi-square test was used to check for the association of prevalence of dental caries and deleterious habits with age among the construction workers. Analysis of variance (ANOVA) test was used to check for any significant differences in the DMFT and OHI-S scores. Multiple linear regression was also performed to assess the predictors for DMFT and OHI-S. For all the tests, confidence level and level of significance were set at 95% and 5%, respectively.

Results

A total of 610 migrant construction workers were included, with 552 (90.5%) being males and 58 (9.5%) being females. The study population was distributed into four age groups: 21-30 (23.8%), 31-40 (35.6%), 41-50 (28.4%), and 51-60 (12.3%), respectively. The mean age of the population was 36.83 ± 10.45 (Tab. I).

Tab. I. Demographic profile of the participants based on Gender, Age group and mean age.

Demographics variables	Frequency (%) N = 610 (100%)
Gender	
Male	552 (90.5%)
Female	58 (9.5%)
Age Group	
21-30	145 (23.8%)
31-40	217 (35.6%)
41-50	173 (28.4%)
51-60	75 (12.3%)
Age (Mean ± SD)	36.83 ± 10.45

SD: Standard deviation; All values are expressed as frequency with percentages (in parentheses) and mean ± SD.

Dental caries and oral hygiene status among construction workers:

The prevalence of dental caries among construction workers was found to be 81%. Figure 1 depicts the age-wise distribution of dental caries. The highest prevalence was observed in the age group of 31-40 (89.4%) and the lowest in 21-30 (62.8%). When Chi-square test was applied, there was a statistically significant difference in caries prevalence among the different the age groups ($p < 0.001$) (Tab. II).

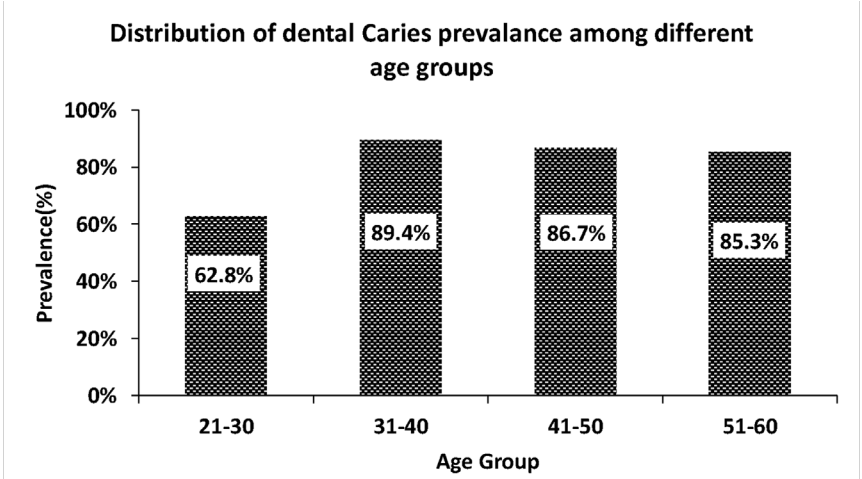
The mean DMFT of construction worker was found to be 6.77 ± 4.76. The highest DMFT index score was in the age group of 41-50 (9.78 ± 3.61), while the lowest was in 21-30 (2.72 ± 3.03). Furthermore, when examining the individual components of the DMFT index, the filled component was highest in the age group of 31-40 (0.24 ± 0.43) and lowest in the 51-60 (0.04 ± 0.20). The missing component was highest in the age group of 51-60 (3.64 ± 2.90) and the lowest in 21-30 (0.41 ± 0.95). There was a statistically significant difference in the mean DMFT score across the four age groups using ANOVA test ($p < 0.001$) (Tab. II).

The mean OHI-S Index score of construction workers was found to be 2.55 ± 1.13. Figure 2 depicts the distribution of Oral hygiene status among construction workers. It was observed that 51.3% of workers had fair oral hygiene, while 36.9% had poor, and only 11.8% had good oral hygiene. The highest mean OHI-S index score was in the age group of 41-50 (2.90 ± 1.25), while the lowest was in 21-30 (1.96 ± 0.70). There was a statistically significant difference in the mean OHI-S index score across the four age groups using ANOVA test ($p < 0.001$) (Tab. II).

Deleterious Habits among construction workers

The prevalence of smoking, tobacco chewing habit, and alcohol consumption among the construction workers was found to be 21.6%, 59.9%, and 37.3%, respectively. Smoking was most prevalent in the age group of 51-60, while tobacco chewing habit and alcohol consumption was highest in the 41-50 age group. There was a statistically significant association found between smoking ($p = 0.003$), tobacco chewing ($p < 0.001$), and alcohol consumption ($p = 0.038$) with different age groups when the chi-square test was applied (Tab. III).

Fig. 1. Distribution of dental caries prevalence among different age groups of construction workers; All values are expressed in percentages.



Tab. II. Distribution of oral hygiene status, DMFT and prevalence of dental caries among different age groups of construction workers.

Parameter	Age group n (%)				p-value
	21-30	31-40	41-50	51-60	
OHI-S$^{\alpha}$	1.96 ± 0.70	2.53 ± 1.04	2.90 ± 1.25	2.89 ± 1.26	< 0.001*
DMFT$^{\alpha}$	2.72 ± 3.03	6.30 ± 4.75	9.78 ± 3.61	8.96 ± 3.71	< 0.001*
Caries prevalence$^{\beta}$					
Caries present	91 (62.8%)	194 (89.4%)	150 (86.7%)	64 (85.3%)	< 0.001*
Caries absent	54 (37.2%)	23 (10.6%)	23 (13.3%)	11 (14.7%)	

OHI-S: Oral Hygiene Index-Simplified; DMFT: Decayed Missing Filled teeth; All values are expressed as frequency with percentages (in parentheses) and Mean ± standard deviation (SD). The statistical test used: $^{\alpha}$ ANOVA, $^{\beta}$ Chi-square test; level of significance: * $p \leq 0.05$ is considered statistically significant.

Tab. III. Distribution of Deleterious habits (Smoking, Tobacco and Alcohol) in different age groups.

Deleterious habits	Age groups n (%)				p-value
	21-30	31-40	41-50	51-60	
Smoking					
Smokers	38 (26.2%)	34 (15.7%)	35 (20.2%)	26 (34.7%)	0.003*
Non smokers	107 (73.8%)	183 (84.3%)	138 (79.8%)	49 (65.3%)	
Tobacco chewing					
Tobacco users	72 (49.7%)	121 (55.8%)	119 (68.8%)	57 (76%)	< 0.001*
Non-tobacco users	73 (50.3%)	96 (44.2%)	54 (31.2%)	18 (24%)	
Alcohol					
Alcohol users	56 (38.6%)	81 (37.3%)	75 (43.4%)	18 (24%)	0.038*
Non-alcohol users	89 (61.4%)	136 (62.7%)	98 (56.6%)	57 (76%)	

All values are expressed as frequency with percentages (in parentheses). The statistical test used: Chi-square test; level of significance: * $p \leq 0.05$ is considered statistically significant.

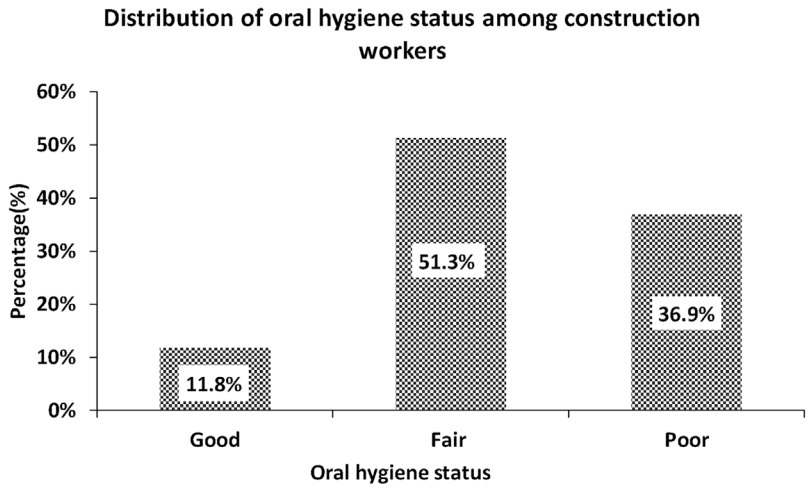
Association between demographic variables and deleterious habits with oral hygiene status and DMFT

The multiple linear regression model revealed that oral hygiene status was significantly associated with age and tobacco chewing, whereas DMFT was significantly associated with age, gender, tobacco chewing, and alcohol consumption. The dependence of OHI-S and DMFT on predictors such as age, gender and habits such as smoking, tobacco chewing and alcohol consumption was found to be 21.5% and 39.6%, respectively (Tab. IV).

Discussion

India lacks a centralized infrastructure for national oral health services, distinct from more developed countries. Focusing on the oral health status of construction workers becomes imperative to underscore the necessity for targeted health promotion and consistent oral health care services. This emphasis aims to facilitate essential health education initiatives and the implementation of preventive and curative dental care services. By elucidating the unique oral health challenges faced by

Fig. 2. Distribution of oral hygiene status among construction workers; All values are expressed in percentages.



Tab. IV. Association between Oral Hygiene Index-Simplified (OHI-S) and Decayed, Missing and Filled Teeth (DMFT) with age, gender, alcohol, smoking and tobacco.

Parameters	Coefficient r	SE	t	95% CI	p-value	Adjusted R^2
Dependent variable: OHI-S						
Constant		0.246	4.498	0.624 to 1.592	< 0.001*	0.215
Age	0.281	0.004	7.518	0.022 to 0.038	< 0.001*	
Gender	-0.029	0.146	-0.766	-0.398 to 0.175	0.444	
Smoking	-0.011	0.107	-0.285	-0.241 to 0.180	0.776	
Tobacco	0.303	0.099	7.026	0.502 to 0.892	< 0.001*	
Alcohol	0.034	0.088	0.893	-0.095 to 0.252	0.372	
Dependent variable: DMFT						
Constant		0.913	-0.728	-2.459 to 1.129	0.467	0.396
Age	0.542	0.015	16.540	0.218 to 0.276	< 0.001*	
Gender	-0.092	0.541	-2.760	-2.556 to -0.431	0.006*	
Smoking	-0.023	0.397	-0.675	-1.048 to 0.512	0.500	
Tobacco	0.134	0.368	3.540	0.580 to 2.025	< 0.001*	
Alcohol	-0.204	0.327	-6.113	-2.645 to -1.359	< 0.001*	

CI: confidence interval; SE: standard error; OHI-S: Oral Hygiene Index-Simplified; DMFT: Decayed Missing Filled teeth. The statistical analysis used: multivariate linear regression; Level of significance: * $p \leq 0.05$ is considered statistically significant.

migrant construction workers, a clearer understanding emerges of the imperative to institute comprehensive interventions. The present cross-sectional study aimed at assessing the dental caries, oral hygiene status and deleterious habits among migrant construction workers of Belagavi.

In the developing countries, internal migration is a survival strategy for many workers in search of better livelihood and opportunities. The present study was conducted among 610 migrant construction workers with a larger proportion of males than females which could be due to the safety concerns and the physical strength required for this line of work. The participant age ranged from 21 to 60 years with an average age of 36.83 ± 10.45 which was in congruence to a study conducted by Suresh et al., among the migrant workers in Chennai where most of the workers employed were above 25 years [21].

In the present study, the prevalence of dental caries was high among the age groups of 31-40 and 41-50. This finding aligns with the outcomes of a previous study conducted by Anil et al., focusing on migrant construction laborers in Tamil Nadu wherein the prevalence was reported to be 81.5% [22]. A study conducted by Sakthi et al., reported that caries prevalence among 321 construction workers was 67% which was less than the finding of present study [23]. There was a high mean DMFT among the participants of this study. Sanadhya et al., stated that the mean DMFT score of the salt workers was (3.94 ± 3.54) which was much lower than the findings of the current study (6.77 ± 4.76) [24]. The study also identified a low number of filled teeth among construction workers, indicating an increased requirement for dental treatments and highlighting potential disparities in access to oral healthcare services within this demographic in Belagavi. The high caries prevalence among construction workers in Belagavi can be attributed to a combination of occupational and environmental factors. Construction workers often face challenging working conditions that contribute to poor oral hygiene practices among them, as

the nature of their work may limit their ability to maintain regular dental routines. Additionally, the demanding nature of construction jobs often leads to irregular eating patterns and reliance on convenient, often sugary, snacks and beverages, further exacerbating the risk of dental caries. Limited access to dental care and preventive services may also play a role, as construction workers may prioritize work commitments over seeking regular dental check-ups.

In this study, 36.9 % of the construction workers had poor oral hygiene status as deciphered by the oral hygiene index scores. In a study conducted by Bipina et al., 79.41% construction workers had poor oral hygiene and it was found that people who brushed once daily had poor oral hygiene and periodontitis [25]. Since majority of them are from rural areas, where it is presumed that they have low awareness of oral hygiene practices and consistently disregard oral health use of locally available material instead of a tooth brush and paste due to material shortage or cost concerns could be the primary cause of poor oral hygiene status among them. The workplace environment of the individuals has an influence on their oral health statuses through the behaviour and habits which are exerted by their personal and work characteristics. This observation suggests a potential correlation between the construction workers' frequency of tooth brushing, limited to once a day, and factors such as prolonged occupational demands and sleep deprivation.

Among the 610 construction workers, 59.9% self-reported tobacco use. These findings align with previous studies; Anil et al., reported a tobacco usage rate of 80.7% among construction workers, while Bipina et al., observed that smokeless tobacco (47.07%) was the predominant habit within this occupational group [22, 25]. The tobacco consumption in the study was lesser than that reported by Ansari et al., [26] (85.9%) and Aslesh et al., [27] (71.7%), but it was greater than that which was reported by Mou et al., [28] (19.1%) and Dagli et al., [29] (40.3). The National Oral Health Survey and Fluoride Mapping showed that the prevalence of smoking was 22.8% among 35- to 44-year-olds in India which was similar to this study. A rather smaller proportion of cigarette smoking (21.6%), which was similar to finding by Anil et al., [22] (25.3%), and Tirukkovalluri et al., [30] (29%). In the current study, 37.3 % of the participants reported alcohol consumption, a prevalence consistent with the findings of Anil et al., [22] (31.5%). However, this rate was lower compared to the observations reported by Aslesh et al. [27] (56.6%) and Zabeer et al. [31] (60.2%). According to World Cancer Report, in 2018 India reported 1.16 million new cancer cases and 784,800 deaths related to cancer in a population of 1.3 billion. Vulnerable population groups such as migrant workers were identified as emerging high risk groups for oral cancer owing to the high prevalence of smokeless tobacco consumption [32]. In the present study, the regression models revealed there was significant relationship between demographic profile and deleterious habits of construction workers with their oral health. These findings aligns with those reported by Varkey et al., among fishermen population [7]. Implementing measures to reduce deleterious habits, particularly tobacco use, among construction workers can significantly enhance their oral health outcomes. Scientific evidence consistently links tobacco consumption to a heightened risk of oral health issues, including periodontal diseases and oral cancers. The cessation of tobacco use within this occupational group may lead to marked improvements in their oral health.

Limitations

This study is constrained by its cross-sectional design, preventing the establishment of a temporal relationship between lifestyle factors and oral health status. The inherent limitation lies in the inability to discern the causality or directionality of the observed associations. To address this limitation and enhance the depth of understanding, a longitudinal study focusing on the same target group is required. A longitudinal approach would provide a more comprehensive insight into the dynamic interplay between lifestyle factors and oral health among construction workers.

Further scope and recommendations

In contrast to several affluent nations, India lacks a comprehensive national oral health service. Although certain welfare schemes for construction workers in states like Delhi and Assam, which focuses on general healthcare, providing medical assistance for accidents and reimbursement for major diseases, dental health services are notably absent from these initiatives [33, 34]. Internationally, countries such as the UAE have successfully implemented dental health screening sessions through collaborations with dental clinics and educational institutions [35]. Drawing inspiration from these endeavours, India could benefit from coordinated efforts involving dental professionals, local manufacturing authorities, social and economic sectors, and volunteer organizations.

Establishing routine oral health care services for construction workers is imperative to provide essential health education, preventive measures, and curative dental treatments. These services should be tailored to address the specific challenges faced by the workforce, incorporating regular oral health education programs, workshops, and accessible on-site dental clinics. Targeted health promotion activities are essential, focusing on tobacco and alcohol cessation among migrant construction workers, aligning with an overarching strategy for promoting their oral health. To further reduce the incidence of caries and enhance their oral hygiene, fluoride application programs, dental sealant initiatives, and community-driven oral health campaigns should be implemented. Additionally, providing affordable and culturally sensitive interventions, such as access to oral care products and peer support, contributes to a comprehensive approach aimed at improving the oral health and overall well-being of this diverse and vital workforce.

Conclusions

This study revealed that the prevalence of dental caries was found to be high, oral hygiene status was poor, and high prevalence of deleterious habits such as tobacco was found among migrant construction workers in Belagavi, India. The current study emphasizes the necessity of an intervention to raise awareness and offer dental health education programs in order to improve the oral health of construction workers. Individuals from lower socioeconomic backgrounds desire genuine authority over decisions prioritising prophylaxis, timely diagnosis and adequate treatment delivery.

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Conflict of interest statement

There was no conflict of interests associated with this original research article.
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Authors' contributions

AP: conceptualization, investigation, project administration, visualization, writing-original draft, writing review and editing. SJ: resources, supervision, validation, data curation, formal analysis, methodology. AVA: resources, supervision, validation, writing-original draft, writing-review and editing. VNS: conceptualization, investigation, project administration, visualization, writing-original draft, writing-review and editing. KR: resources, supervision, methodology, validation, writing-review and editing. JT: software, data curation, writing-original draft and data curation. DC: resources, supervision, validation, data curation, formal analysis, methodology. LK: software, data curation, writing-original draft, writing-review and editing.

References

[1] Santhosh VN, Ankola A, Sankeshwari R, Jalihal S, Varghese AS, Chavan P, Shah MA. Impact of dental caries and periodontal disease on oral health-related quality of life among the Karnataka State Reserve Police Personnel in Belagavi, India. J Prev Med Hyg 2023;64:E78-E86. https://doi.org/10.15167/2421-4248/jpmh2023.64.1.2900.

[2] Spanemberg JC, Cardoso JA, Slob EMGB, López-López J. Quality of life related to oral health and its impact in adults. J Stomatol Oral Maxillofac Surg 2019;120:234-9. https://doi.org/10.1016/j.jormas.2019.02.004.

[3] Gil-Montoya JA, de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. Clin Interv Aging 2015;10:461-7. https://doi.org/10.2147/CIA.S54630.

[4] Lula EC, Ribeiro CC, Hugo FN, Alves CM, Silva AA. Added sugars and periodontal disease in young adults: an analysis of NHANES III data. Am J Clin Nutr 2014;100:1182-7. https://doi.org/10.3945/ajcn.114.089656.

[5] Rooban T, Vidya K, Joshua E, Rao A, Ranganathan S, Rao UK, Ranganathan K. Tooth decay in alcohol and tobacco abusers. J Oral Maxillofac Pathol 2011;15:14-21. https://doi.org/10.4103/0973-029X.80032.

[6] Manicone PF, Tarli C, Mirijello A, Raffaelli L, Vassallo GA, Antonelli M, Rando MM, Mosoni C, Cossari A, Lavorgna L, Caputo F, D'Addona A, Gasbarrini A, Addolorato G. Dental health in patients affected by alcohol use disorders: a cross-sectional study. Eur Rev Med Pharmacol Sci 2017;21:5021-7. https://doi.org/10.26355/eurrev_201711_13811.

[7] N S V, Vas R, Uppala H, Vas NV, Jalihal S, Ankola AV, K RSK. Dental caries, oral hygiene status and treatment needs of fishermen and non-fishermen population in South Goa, India. Int Marit Health 2022;73:125-32. https://doi.org/10.5603/IMH.2022.0025.

[8] Ghasemi H, Darmohammadi R, Namdari M, Ghorbani Z. Oral health outcomes and shift working among male workers: A cross-sectional survey. PLoS One 2022;17:e0275924. https://doi.org/10.1371/journal.pone.0275924.

[9] Greenspan D. Xerostomia: diagnosis and management. Oncology (Williston Park) 1996;10(3 Suppl):7-11.

[10] Hong M-H. The Influence of occupational stress on dry mouth, temporomandibular disorder and oral symptoms on workers. J Korean Soc Dent Hyg 2013;13:136-45. https://doi.org/10.13065/jksdh.2013.13.1.136.

[11] Aranha RLB, Martins RC, de Aguilar DR, Moreno-Drada JA, Sohn W, Martins CC, de Abreu MHNG. Association between stress at work and temporomandibular disorders: a systematic review. Biomed Res Int 2021;2021:2055513. https://doi.org/10.1155/2021/2055513.

[12] Tiwary G, Gangopadhyay PK. A review on the occupational health and social security of unorganized workers in the construction industry. Indian J Occup Environ Med 2011;15:18-24. https://doi.org/10.4103/0019-5278.83003.

[13] Aktas E, Bergbom B, Godderis L, Kreshpaj B, Marinov M, Mates D, McElvenny DM, Mehlum IS, Milenkova V, Nena E, Glass DC. Migrant workers occupational health research: an OMEGA-NET working group position paper. Int Arch Occup Environ Health 2022;95:765-77. https://doi.org/10.1007/s00420-021-01803-x.

[14] World Statistic - 2011. Available at: http://www.ilo.org/moscow/areas-of-work/occupational-safety-and-health/WCMS_249278/lang--en/index.htm (Accessed on: 14/10/2023).

[15] Safety training for migrant workers in the construction industry: a systematic review and future research agenda - PubMed. Available on: https://pubmed.ncbi.nlm.nih.gov/32068414/ (Accessed on: 14/10/2023).

[16] Ali AK, Mohammed A, Thomas AA, Paul S, Shahul M, Kasim K. Tobacco Abuse and Associated Oral Lesions among Interstate Migrant Construction Workers. J Contemp Dent Pract 2017;18:695-9. https://doi.org/10.5005/jp-journals-10024-2109.

[17] Cepova E, Cicvakova M, Kolarcik P, Markovska N, Geckova AM. Associations of multidimensional health literacy with reported oral health promoting behaviour among Slovak adults: a cross-sectional study. BMC Oral Health 2018;18:44. https://doi.org/10.1186/s12903-018-0506-6.

[18] India - Global Adult Tobacco Survey 2016. Available at: https://extranet.who.int/ncdsmicrodata/index.php/catalog/861 (Accessed on: 14/10/2023).

[19] Oral health surveys: basic methods - 5th edition. Available at: https://www.who.int/publications-detail-redirect/9789241548649 (Accessed on: 27/06/2022).

[20] Greene JC, Vermillion JR. The simplified oral hygiene index. J Am Dent Assoc 1964;68:7-13. https://doi.org/10.14219/jada.archive.1964.0034.

[21] Suresh S, Doraikannan S, Jayakumar ND, Indiran MA, Kesavan R. Working hours impact on the sleep quality and oral health status among migrant construction workers in Chennai. J Family Med Prim Care 2022;11:3511-6. https://doi.org/10.4103/jfmpc.jfmpc_2101_21.

[22] Anil Raj. Oral Health Status and Treatment Needs of Immigrant Construction Workers in Chennai City: A Cross Sectional Survey. Masters. Chennai, India: Ragas Dental College and Hospital 2016.

[23] Periodontal health status and treatment needs among building construction workers in Chennai. India - Semantic Scholar. https://www.semanticscholar.org/paper/Periodontal-health-status-and-treatment-needs-among-Sakthi-John/7c07fd8b65746258916ce2a3841b377b0ee2e744 (Accessed on: 11/11/2023).

[24] Sanadhya S, Nagarajappa R, Sharda AJ, Asawa K, Tak M, Batra M, Daryani H. The oral health status and the treatment needs of salt workers at sambhar lake, jaipur, India. J Clin Diagn Res 2013;7:1782-6. https://doi.org/10.7860/JCDR/2013/5887.3275.

[25] Bipina P, Manjushree Kadam, Nasila Mohammed, Anjali Jain. Awareness and assessment of oral hygeine and periodontal status among the construction workers in a j hospital campus, Mangalore. Int J Cur Res Rev 2015;7:36-43.

[26] Ansari ZA, Bano SN, Zulkifle M. Prevalence of tobacco use among power loom workers - a cross-sectional study. Indian J Community Med 2010;35:34-9. https://doi.org/10.4103/0970-0218.62551.

[27] Aslesh OP, Paul S, Paul L, Jayasree AK. High Prevalence of Tobacco Use and Associated Oral Mucosal Lesion Among Interstate Male Migrant Workers in Urban Kerala, India. Iran J Cancer Prev 2015;8:e3876. https://doi.org/10.17795/ijcp-3876.

[28] Mou J, Fellmeth G, Griffiths S, Dawes M, Cheng J. Tobacco smoking among migrant factory workers in Shenzhen, China. Nicotine Tob Res 2013;15:69-76. https://doi.org/10.1093/ntr/nts085.

[29] Dental Health among Green Marble Mine Laborers, India. Available at: https://www.researchgate.net/publication/228468521_Dental_Health_among_Green_Marble_Mine_Laborers_India (Accessed on: 2712/2023).

[30] Workplace based Potentially Malignant Oral Lesions Screening among Tobacco Consuming Migrant Construction Site Workers in Chennai, South India: A Pilot Study - PubMed. Available at: on: https://pubmed.ncbi.nlm.nih.gov/33209836/ (Accessed on: 2/12/2023).

[31] Zabeer S, Inbaraj LR, George CE, Norman G. Quality of life among migrant construction workers in Bangalore city: A cross-sectional study. J Family Med Prim Care 2019;8:437-42. https://doi.org/10.4103/jfmpc.jfmpc_424_18.

[32] World Cancer Report. Available at: https://www.iarc.who.int/cards_page/world-cancer-report (Accessed on: 2/12/2023).

[33] Welfare Schemes - Delhi Building and Other Construction Workers Welfare Board. Available at: https://bocw.delhi.gov.in/bocw/welfare-schemes (Accessed on: 2/12/2023).

[34] Various Welfare Benefits for Registered Construction Workers - Labour Welfare - Government of Assam, India. Available at: https://labour.assam.gov.in/portlet-innerpage/various-welfare-benefits-for-registered-construction-workers (Accessed on: 2/12/2023).

[35] Mesmar HSA, John S. Overview of oral and dental healthcare in Dubai health authority: status, gaps, and initiatives, 2016-2021. Int J Sci Rep 2023;9:267-72. https://doi.org/10.18203/issn.2454-2156.IntJSciRep20232172.

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Occupation Medicine and Hygiene

Assessment of workhour feeding practices, healthy behaviour score and body mass index of physicians in Northern Nigeria: a cross-sectional multi-centre study

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Keywords

Body mass index • Lifestyle behaviour • Obesity • Physicians • Workhour feeding practices

Summary

Background. *The increasing prevalence of obesity and overweight among health workers calls for an appraisal of their lifestyle. This study assessed medical practitioners' workhour feeding and lifestyle practices and explored the relationship between these practices and their body mass index (BMI).*

Methods. *The survey involved 321 medical practitioners selected from 9 northern Nigeria hospitals in 2021. Data collected included biodata, medication history, workhour feeding characteristics, lifestyle behaviours, blood pressure, height, and weight measurements. Data were analyzed using Epi info software (version 7).*

Results. *Most respondents were male (70.7%). Their mean age was 38 ± 7.4 years. During their last workhours, 84.1% had lunch, and 46.4% took sugary drinks. Usually, 41.7% source their lunch from the hospital canteen, and 18.7% patronize their canteen at least weekly. Most reported healthy behaviour towards alcohol consumption (99.7%), fruit and vegetable consumption (54.8%) and smoking (98.4%). However, only 22.4% were physically active. Their mean healthy behaviour score and BMI were 2.8 ± 0.7 and 26.1 ± 4.6 kg/m^2, respectively. The obesity and overweight rates were 18.4% and 37.7%, respectively. Their source of lunch during workhours, age, sex, years of practice, employment duration, marital status, job category, systolic blood pressure, anti-hypertensive, and antidiabetic medication use were significantly associated with mean BMI. However, only antihypertensive medication use, being married, inadequate fruit/vegetable consumption and workhour sugary drinks consumption predicted obesity. The predictors of overweight/obese were years of practice (< 10 y) and use of antihypertensive medications.*

Conclusions. *Obesity and overweight rates were high. Most were physically inactive. Workhour sugary drink consumption predicted obesity. Effective workplace and community interventions to improve practitioners' lifestyle behaviour and curtail obesity and overweight are needed.*

Introduction

Obesity and overweight have become a global public health problem. In 2016, about 1.9 billion adults aged ≥ 18 years globally were at least overweight. Out of this, 650 million were obese [1]. Unhealthy lifestyle behaviours, including unhealthy diet, physical inactivity, smoking and alcohol consumption are important modifiable factors responsible for the development of non-communicable diseases (NCDs), including obesity [2, 3]. In Nigeria, NCDs were estimated to have caused 29% of the total mortalities in 2016, with cardiovascular diseases (11%), cancers (4%), and diabetes (1%) being the top three causes [4]. The link between lifestyle health behaviours and NCDs has been demonstrated with individual lifestyle practices and the collection of lifestyle practices (*i.e.,* health behaviour score) [3, 5].

Studies have shown that many healthcare industry employees are overweight and obese; at least half of healthcare workers in several studies are obese or overweight [6-13]. This clearly endangers their position as role models of healthy behaviour to their patients. Also, physicians who exercise sufficiently are more likely to counsel their patients on physical activity and healthy diet [14, 15]. Unfortunately, studies indicate that many healthcare professionals are physically inactive, consume unhealthy foods and drinks, and do not consume enough fruits and vegetables, even during workhours [16-20]. The risk factors for obesity in healthcare workers include older age, gender, marital status, job category, black race, and comorbidity [7, 9-11, 13]. Given the mentally and physically demanding nature of the hospital-based physician's job, it is essential to provide healthy

nutrition needed for optimal performance in the workplace [21]. However, access to healthy workplace nutrition can be challenging during workhours. Earlier studies in the UK showed that National Health Service (NHS) doctors had difficulty obtaining healthy nutrition during workhours due to unsupportive employers, unfavourable canteen opening times, lack of selection and meal breaks [22]. Similar findings were also reported among nurses [23, 24].

To our knowledge, no data exists on the feeding practices of Nigerian medical doctors during workhours or the association between their workhour feeding practices and body mass index (BMI). Hence, we examined the workhour feeding practices, healthy behaviour scores, and the BMI of medical practitioners in Northern Nigeria. We also assessed for any associations between the workhour feeding practices, healthy lifestyle practices and BMI. We hope the study provides valuable baseline information for strategic planning toward improving the health of medical practitioners in the region.

Materials and methods

Study design, setting, and population

This multicentre survey was carried out in 2021 (September to December). It involved medical practitioners of different specialties working in selected federal tertiary hospitals in Northern Nigeria. Northern Nigeria comprises three geopolitical zones: the northcentral (with five states and the Federal Capital Territory), northeast (6 states) and northwest (7 states). Each state has at least one federal tertiary hospital. Nine hospitals were selected for the study: Northcentral zone (Jos University Teaching Hospital [JUTH] Jos, Federal Medical Centre [FMC] Keffi, and FMC Lokoja); Northeast zone (FMC Nguru, University of Maiduguri Teaching Hospital [UMTH] Maiduguri and Abubakar Tafawa Balewa University Teaching Hospital [ATBUTH] Bauchi; and Northwest zone (Aminu Kano Teaching Hospital [AKTH] Kano, Usmanu Dan Fodio University Teaching Hospital [UDUTH] Sokoto, and FMC Birnin Kudu).

Eligibility criteria

Medical practitioners who had worked for at least six months during the study period were included in the study. Those who declined consent to participate were excluded.

Sample size estimation

A sample size of 347 was calculated using Epi info (version 7), considering a 95% confidence interval, an empirical physician obesity rate of 50% (given the lack of data in Nigeria), a finite population of 990 (estimated number of practitioners available for selection in the nine hospitals during the study period), and a non-response/missing data rate of 20%.

Sampling technique

A multistage sampling technique was employed. First, three states were selected from each of the three geopolitical zones by balloting. Second, one federal tertiary hospital was selected from each of the nine selected states also by balloting. Finally, the principal investigator sent the Google form link via WhatsApp or email to the study site coordinators. Then, the site coordinators sent the link to the WhatsApp platforms of resident doctors and consultants association in their hospital. Monthly reminders were sent until the study was completed.

Data collection

Following an extensive review of the literature, we developed a semi-structured interviewer-administered questionnaire in English. The questionnaire was then pretested on 30 medical practitioners at Murtala Mohammed Specialist Hospital in Kano (not selected for the main study) for comprehensibility, reduction of measurement error, and internal validity. It was modified based on information obtained from the pretest. For logistic reasons, the questionnaire was deployed for online (Google form) interviews in eight study sites and face-to-face interviews at one site. Data collected were sociodemographic characteristics, workhour feeding characteristics, medication history and lifestyle behaviours, blood pressure and anthropometric measurements. As a prerequisite, participants obtained their heights (metres), and recent weights (kg) and blood pressure (mmHg) following standard protocols before completing the questionnaire. Recent measurements were measurements taken not more than one week from the day of filling the form. They were also instructed to fill out the questionnaires only once. The online form required all entries in the form before submission. Self-reported blood pressures, heights, and weights were used because the participants were tertiary hospital medical doctors, and this strategy has been successfully used in other studies [16, 19].

Definition and measurement of variables

1. Outcome variable: Body mass index (BMI); Calculated by the investigator using the formula (weight/height^2[kg/m^2]). Categorized into: Normal weight (18.5-24.9), overweight (25.0-29.9), obesity (≥ 30), and underweight (< 18.5) [25].
2. Independent variables: Sociodemographic characteristics, medication history, blood pressure, healthy lifestyle behaviours, and workhour feeding characteristics.
3. Healthy behaviours: (a) Sufficient physical activity: Engaging in moderate and vigorous physical activities for 150 and 75 minutes the preceding week, respectively. We used the Physical Activity Assessment Tool [26]. (b) Fruits and vegetable consumption: Using the question, "*In the last 7 days, how many days did you eat fruits/vegetables?*" Adequate, if responses were "All times", or "Most times", and inadequate, if responses were "Sometimes",

"Rarely" or "None" [27]. (c) Alcohol consumption: Using the question: *"In the last 12 months, how often did you drink alcohol?"* It was described as healthy behaviour if responses were "Sometimes", "Rarely', or "None", and unhealthy behaviour if responses were 'All times" or "Most times" [27]. (d) Current smoker (Unhealthy behaviour): currently smoking or stopped smoking < 1 year before the study; healthy behaviour: not a current smoker [28]. (e) Healthy behaviour scores: One point was awarded for each healthy behaviour. The minimum score was 0 (no healthy behaviour), and the maximum was 4 (presence of all four healthy behaviours) [29].

4. Systolic blood pressure ≥ 140 mmHg and or diastolic blood pressure ≥ 90 mmHg were considered hypertension [30].
5. Workhour feeding practices: (a) Skipping breakfast: Assessed using the question, "*Do you take breakfast at home on a typical workday?*" A response of "Yes" was a healthy practice, while "No" was an unhealthy practice [31]. (b) Lunch meal: assessed using the question, "*What did you take for lunch during your last workhours?"* responses of "Full meal" or "Nothing (skipped lunch)" were considered healthy practices, while responses of "Snacks with sugary drinks" or "Sugary drinks only" were considered unhealthy practices [32]. (c) The usual source of lunch during workhours: Responses were categorised into "Hospital canteens or Other sources" and "Home or Skips lunch"

Ethical approval

Ethical approvals were obtained from the Research Ethics Committee of Aminu Kano Teaching Hospital, Kano (NHREC/28/01/2020/AKTH/EC/2798), the Health Research Ethics Committee of Federal Medical Centre Birnin Kudu (FMC/HREC/APP/CLIN/001/187), and Research Ethics Committee of Federal Medical Centre Lokoja (FMCL/MED/115/Vol.II/484). The study objectives were explained before seeking respondents' consent to participate. The study protocol conformed with all other principles of the Helsinki Declaration.

Data analysis

Data from the online Google form entries were exported to Microsoft Excel. Data received from one site were entered manually. All data were analyzed using Epi Info Version 7.2.4 (CDC, Atlanta, GA, USA). Categorical variables were summarized in tables as frequencies and percentages, while numerical variables were reported as mean and standard deviation. Fisher's exact test was used to assess the association between categorical variables. Normally distributed numerical variables were compared using the Student's t-test, while the Mann-Whitney test was used to compare skewed numerical data. The predictors of obesity and combined overweight and obesity were determined using a multivariate logistic regression analysis. The logistic regression model included independent variables with a *p*-value of < 0.1 in the bivariate analysis. Use of lipid-lowering medication, and alcohol consumption were excluded because of their low cell frequency sizes. Skipping breakfast, other healthy behaviours and behaviour scores were considered a priori confounding variables and were included in the final model. A p-value of < 0.05 was considered significant.

Results

There were 249 online and 74 face-to-face respondents. Two (face-to-face) respondents had insufficient data. Therefore, 321 respondents were analyzed, representing a 92.5% completion rate.

Sociodemographic, anthropometric, and blood pressure characteristics

The respondents' mean age was 38 ± 7.4 (range: 23-60) years. Most were male (n = 227, 70.7%), married (256, 79.8%), and from the Northwest geopolitical zone (169, 52.6%, comprising Kano [97, 30.2%], Birnin Kudu [21, 6.5%], and Sokoto [51, 15.9%]). Other zones included Northcentral (92, 28.7%), comprising Jos [2, 0.6%], Lokoja [74, 23.1%] and Keffi [16, 5.0%], and the Northeast (60,18.7%, comprising Bauchi [30, 9.4%], Maiduguri [21, 6.5%] and Nguru [9, 2.8%]) (Tab. I). Most (181, 56.4%) had practiced for ≥ 10 years since graduation.

Their mean height and weight were 1.7 ± 0.1 (range: 1.50-1.98) metres and 74.8 ± 14.1 (range:43.0-130.0) kg, respectively. Their mean BMI was 26.1 ± 4.6 (range: 17.0-42.2) kg/m^2. Also, 121 (37.7%) respondents were overweight, while 59 (18.4%) were obese. Their mean systolic and diastolic blood pressures were 118.5 ± 10.2 (range: 90-150) and 76.3 ± 8.0 (range: 50-100) mmHg, respectively.

Workhour feeding practices

About 136 (42.4%) respondents skipped breakfast on a typical workday (Tab. II). Most (273, 85.1%) had no official meal or break time in their hospital; 270 (84.1%) respondents had lunch during their last workhours. About 46.4% (n = 149) of respondents snacked on carbonated sugary drinks with or without cakes, meat pie, biscuits, *etc*. during their last workhours. About 41.7% (n = 134) usually got their lunch from their hospital canteen during workhours. However, 46.7% (n = 150) had never or rarely used their hospital canteen; 5% (16) used canteen services daily, while 18.7%(n = 60) used the canteen at least weekly. Although 226 (70.4%) respondents rated the hospital canteen meals as healthy, 27.1% (n = 87) felt otherwise. Reasons given for this position were under the themes "Dirty canteen environment" 41.4% (36/87), followed by "Poor quality/Not balanced/No variety/No fruits" 33.3% (29/87).

Healthy lifestyle behaviours and medication history

Most respondents reported healthy behaviours regarding alcohol consumption (320, 99.7%), smoking (316, 98.4%), and fruit and vegetable consumption (176,

Tab. I. Sociodemographic characteristics and body mass index (BMI, kg/m^2).

Variables	Sample n (%)	Mean[t] BMI (SD)	BMI < 18.5 n (%)	BMI 18.5-24.9 n (%)	BMI 25.0-29.9 n (%)	BMI ≥ 30 n (%)	p[(f)]
Sex							
Male	227 (70.7)	26.2 (4.3)*	4 (1.8)	89 (39.2)	97 (42.7)	37 (16.3)	0.013*
Female	94 (29.3)	25.9 (5.3)	5 (5.3)	43 (45.8)	24 (25.5)	22 (23.4)	
Age, mean (SD)	38.1 (7.4)						
< 30	34 (10.6)	22.9 (3.8)*	4 (11.8)	30 (58.8)	9 (26.5)	1 (2.9)	0.001*
30-39	169 (52.7)	26.0 ((4.5)	4 (2.4)	75 (44.5)	60 (35.5)	30 (17.7)	
40-49	88 (27.4)	27.0 (4.7)	1 (1.1)	29 (33.0)	39 (44.3)	19 (21.6)	
≥ 50	30 (9.3)	27.7 (3.9)	0 (0)	8 (26.7)	13 (43.3)	9 (30.0)	
Geopolitical zone							0.306
Northcentral zone[a]	92 (28.7)	26.4 (4.7)	2 (2.2)	37 (40.2)	31 (33.7)	22 (23.9)	
Northeast zone[b]	60 (18.7)	25.7 (3.9)	0 (0)	28 (46.7)	25 (41.7)	7 (11.7)	
Northwest zone[c]	169 (52.6)	26.0 (4.7)	7 (4.1)	67 (39.6)	65 (38.5)	30 (17.8)	
Specialty							0.773
Medical	211 (65.7)	26.2 (4.4)	5 (2.4)	84 (39.8)	83 (39.3)	39 (18.5)	
Surgical	110 (34.3)	25.9 (4.9)	4 (3.6)	48 (43.6)	38 (34.6)	20 (18.2)	
Years of practice							< 0.001*
Median (IQR)[mw]	10 (5-15)						
< 10 y	140 (43.6)	24.6 (4.5)*	8 (5.7)	72 (51.4)	46 (32.9)	14 (10.0)	
≥ 1 0 y	181 (56.4)	27.3 (4.2)	1 (0.5)	60 (33.2)	75 (41.4)	45 (24.9)	
Job category							0.052
Non-consultants	236 (72.5)	25.6 (4.6)*	8 (3.4)	104 (44.1)	88 (37.3)	36 (15.2)	
Consultants	85 (26.5)	27.4 (4.3)	1 (1.2)	28 (32.9)	33 (38.8)	23 (27.1)	
Duration of current employment							
Median (IQR)[mw]	5 (2-9)						
< 5 y	168 (52.3)	25.3 (4.5)*	6 (3.6)	82 (48.8)	58 (34.5)	22 (13.1)	0.033*
≥ 5 y	153 (47.7)	27.0 (4.5)	3 (2.0)	50 (32.7)	63 (41.2)	37 (24.1)	
Current marital status							0.001*
Married[d]	262 (81.6)	26.5 (4.7)*	9 (3.4)	96 (36.6)	101 (38.6)	56 (21.4)	
Single	59 (18.4)	24.2 (3.2)	0 (0)	36 (61.0)	20 (33.9)	3 (5.1)	
SBP (mean [SD]) mmHg	118.5 ± 10.2						
< 140	308 (96.0)	26.0 (4.5)*	9 (2.9)	130 (42.2)	116 (37.7)	53 (17.2)	0.041*
≥ 140	13 (4.0)	29.5 (4.5)	0 (0)	2 (15.4)	5 (38.5)	6 (46.1)	
DBP (mean [SD]) mmHg	76 ± 8.0						
< 90	294 (91.6)	26.0 (4.5)	8 (2.7)	125 (42.5)	110 (37.4)	51 (17.4)	0.279
≥ 90	27 (8.4)	27.4 (5.1)	1 (3.7)	7 (25.9)	11 (40.7)	8 (29.6)	

* Significant ($p < 0.05$); [f] Fisher's exact test; [t] Student t-test; mw Mann-Witney test; [a] Jos University Teaching Hospital, Federal Medical Centre (FMC) Lokoja, and FMC Keffi; [b] Abubakar Tafawa Balewa University Teaching Hospital Bauchi, University of Maiduguri Teaching Hospital, FMC Nguru; [c] Aminu Kano Teaching Hospital, FMC Birnin Kudu, Uthman Dan Fodio University Teaching Hospital Sokoto; [d] Married (n = 256), divorced, and widowed.

54.8%) (Tab. III). However, only 22.4% (n = 72) were physically active. Their mean healthy behaviour score was 2.8 ± 0.7 (range: 0-4). One respondent (0.3%) had 0 healthy behaviour score, and another one had 1 healthy behaviour score; 121 (37.7%), 151 (47.1%), and 47 (14.6%) respondents had 2, 3 and 4 healthy behaviour scores, respectively. Forty-six respondents (14.3%) were using antihypertensive medications.

Comparing workhour feeding practices and body mass index

Table IV shows that respondents who usually brought lunch from home or skipped it had significantly higher mean BMI than those who obtained lunch from the hospital canteen or other sources ($p < 0.05$).

Comparing sociodemographic variables, blood pressure and body mass index

The mean BMI was higher in male (26.2 ± 4.3 kg/m^2) than in female (25.9 ± 5.3 kg/m^2) respondents (Tab. I). The combined overweight and obesity rates were also higher in males (59%) than in females (48.9%). Respondents' mean BMI increased with age; the ≥ 50 years age group had the highest mean BMI (27.7 ± 3.9 kg/m^2). Similarly, a higher mean BMI was observed among some respondents (*i.e.* those who had practiced for ≥ 10 years, who were consultants, who had spent ≥ 5 years in current employment, who were married and who had a systolic blood pressure ≥ 140mmHg) than their corresponding counterparts. These findings were statistically significant.

Tab. II. Workhour feeding characteristics (n = 321).

Variables	n (%)
Do you have breakfast at home on a typical workday?	
Yes	185 (57.6)
No	136 (42.4)
How often do you take lunch during work hours?	
Occasionally	230 (71.7)
Always	34 (10.6)
Often	56 (17.4)
Never	1 (0.3)
Do you have an official lunchtime in your hospital?	
Yes	19 (5.9)
No	273 (85.1)
Don't know	29 (9.0)
Usual source of lunch meal/snack during workhours	
In-hospital canteen	134 (41.7)
Out-of-hospital canteen	73 (22.7)
Home	73 (22.7)
Department meetings	23 (7.2)
Hospital shops/Kiosks	8 (2.5)
Skips lunch	4 (1.3)
Both in- and out-of-hospital canteens	6 (1.9)
What did you take for lunch during your last working hours?	
Full meal	121 (37.7)
Snack on sugary drinks and meat pie/cake/ biscuits, *etc.*	103 (32.1)
Sugary drinks only	46 (14.3)
Skipped lunch	51 (15.9)
Does your hospital have a canteen?	
Yes	289 (90.0)
No	32 (10.0)
How often do you use your hospital canteen?	
Daily	16 (5.0)
2, 3, and > 3 times weekly	44(13.7)
Occasionally	111 (34.6)
Rarely	146 (45.5)
Never	4(1.2)
Do you think the food served by your hospital canteen is healthy?	
Yes	226 (70.4)
No	87 (27.1)
Neutral/Not applicable	8 (2.5)
If your answer is No, why do you think it is unhealthy? (n = 87)*	
Dirty canteen environment	36 (41.4)
Poor quality/unbalanced diet/no variety/no fruits	29 (33.3)
I had diarrhoea after a meal/found a dead insect in my food	9 (10.4)
Unprofessional handling of food/cooking at an unknown place and bringing it here	7 (8.1)
Too spicy/oily/salty	6 (6.9)
No provision for takeaway/small space	2 (2.3)
No reason given	2 (2.3)

* Some respondents gave more than one reason.

Comparing lifestyle behaviours, medication history and body mass index

The respondents using antihypertensive, and antidiabetic medications had higher mean BMI than those who were not ($p < 0.05$) (Tab. III). Although the respondents using lipid-lowering medication had higher mean BMI than those who were not, this association was not statistically significant ($p > 0.05$). The individual healthy lifestyle behaviours and healthy behaviour scores were not significantly associated with BMI ($p > 0.05$).

Predictors of obesity and overweight/ obesity

After adjusting for confounding factors, respondents who were single (OR = 0.25, CI [0.07-0.96], p = 0.043), refrained from sugary drinks during workhours (OR = 0.45, CI [0.23-0.88], p = 0.018), and consumed enough fruits and vegetables(OR = 0.21, CI [0.05-0.87], p = 0.031) were less likely to be obese compared to those who were not (Tab. V). Those using antihypertensive medications were 2.27 times more likely to be obese compared to those who were not (OR = 2.27, CI [1.00-5.11], p = 0.049). Using antihypertensive medication increased the odds of overweight/obesity by 4.83 times compared to those who were not (OR = 4.83, CI [0.12-0.95], p = 0.04). Also, practicing for < 10 years lowered the odds of overweight/obesity compared to those who had not (OR = 0.43, CI [0.19-0.96], p = 0.039).

Discussion

This study investigated the work hour feeding practices, lifestyle practices and BMI of medical practitioners in northern Nigeria. We found that despite evidence linking skipping breakfast to obesity [31], 42% of respondents skip breakfast on a typical workday. This finding is lower than the 76.9% found among Ghanaian health workers [20]. The higher proportion of nurses in the Ghanaian study may explain this difference since nurses usually resume duties earlier than doctors in many settings. However, this finding indicates that some respondents may require meals during work hours, corroborating the 84% of respondents who had lunch during their last work hours.

About 85% of respondents reported the absence of breaks or mealtimes in their hospitals, which aligns with a previous study [22]. This suggests that some practitioners may need to leave their duty post at some point during work hours to eat or drink. Further research is required on how practitioners manage this challenge that can possibly affect patient care.

Sadly, about 10% of respondents stated that their hospital did not have a canteen. This could be hospitals that outsourced their canteen services to private entities within the hospital, while in others, canteen services are outrightly unavailable. This finding indicates limited access to food or drinks during work hours in such settings, leading to employees patronizing external food vendors with its potential negative health implications [16].

Again, 18.7% of respondents used canteen services at least once weekly, differing from the 70% of UK doctors who used canteen services [22]. This difference could

Tab. III. Healthy lifestyle characteristics, medication history, and body mass index (BMI, kg/m^2).

Variables	Sample	Mean t BMI	BMI < 18.5	BMI 18.5-24.9	BMI 25.0-29.9	BMI ≥ 30	p **
	n (%)		n (%)	n (%)	n (%)	n (%)	
Healthy lifestyles							
Healthy alcohol consumption							0.697
Yes	320 (99.7)	-	9 (2.8)	131 (40.9)	121 (37.8)	59 (18.4)	
No	1 (0.3)	-	0 (0)	1 (100)	0 (0)	0 (0)	
Physically active							0.526
Yes	72 (22.4)	26.2 ± 4.3	1 (1.4)	27 (37.5)	32 (44.4)	12 (16.7)	
No	249 (77.6)	26.1 ± 4.7	8 (3.2)	105 (42.2)	89 (35.7)	47 (18.9)	
Eat enough fruits/vegetables							0.619
Yes	176 (54.8)	26.1 ± 4.5	5 (2.8)	68 (38.6)	72 (40.9)	31 (17.6)	
No	145 (45.2)	26.0 ± 4.7	4 (2.8)	64 (44.4)	49 (33.8)	28 (19.3)	
Not currently smoking							0.269
Yes	316 (98.4)	26.1 ± 4.5	9 (2.9)	128 (40.5)	121 (38.3)	58 (18.3)	
No	5 (1.6)	24.5 ± 8.0	0 (0)	4 (80.0)	0 (0)	1 (20.0)	
Healthy behaviour score							
Mean (SD)	2.8 (0.7)						0.777
0-2	123 (38.3)	26.0 ± 4.7	3 (2.4)	55 (44.7)	44 (35.8)	21 (17.1)	
3-4	198 (61.7)	26.2 ± 4.5	6 (3.0)	77 (38.9)	77 (38.9)	38 (19.2)	
Medication history							
Antihypertensive medication use							< 0.001*
No	275 (85.7)	25.6 ± 4.5*	9 (3.3)	126 (45.8)	96 (34.9)	44 (16.0)	
Yes	46 (14.3)	28.8 ± 4.2	0 (0)	6 (13.0)	25 (54.4)	15 (32.6)	
Antidiabetic medication use							0.280
No	314 (97.8)	26.0 ± 4.6*	9 (2.9)	131 (41.7)	118 (37.6)	56 (17.8)	
Yes	7 (2.2)	28.6 ± 2.9	0 (0)	1 (14.2)	3 (42.9)	3 (42.9)	
Lipid-lowering medication use							0.562
No	315 (98.1)	26.1 ± 4.6	9 (2.9)	131 (41.6)	118 (37.5)	57 (18.1)	
Yes	6 (1.9)	27.3 ± 3.2	0 (0)	1 (16.7)	3 (50.0)	2 (33.3)	

* Significant ($p < 0.05$); ** Fisher's exact test; t Student t-test.

be due to barriers such as unfavourable canteen opening times, absence of break time, lack of meal options [22], high cost [19, 20], and perceived unhealthy meals reported by 27% of our respondents. From the business perspective, the low canteen utility may pose a challenge in sustaining services.

Furthermore, 46% of respondents consumed sugary drinks with or without snacks during their last work hours. This percentage is higher than 21.7% reported among healthcare workers in Saudi Arabia and 39.4% in Ghana, but lower than the 55% reported in South Africa [18-20]. Healthcare workers often consume sugary drinks due to their convenience (easy to consume while working), widespread availability and the misconception that they are healthy [20].

Almost all the respondents (99.7%) reported healthy behaviours regarding alcohol consumption. This proportion is higher than the 83.8% of Australian nurses and midwives who did not engage in risky drinking, and much higher than the 35% of healthcare professionals in South Africa who rarely consume alcohol [16, 18]. The predominance of muslims in northern Nigeria may explain this difference, as Islam prohibits the consumption of alcoholic beverages.

Although the consumption of sufficient fruits and vegetables has been associated with weight loss and prevention of weight gain [33], only about half (54.8%) of the respondents consumed sufficient fruits and vegetables. This finding agrees with the 59% of Saudi Arabian healthcare workers who usually consume fruits and vegetables at home, but is higher than the finding in South African healthcare workers who frequently consumed fruits (23%) and vegetables (27%) [18, 19].

The low prevalence of current smokers (1.6%) among the respondents was similar to 1.95% obtained among American doctors between 2010 and 2011 [34], but lower than the rates among medical doctors in Riyad, Saudi Arabia (10.4%) and Australian nurses and midwives (10.3%) [16, 35]. Notably, our finding is lower than the national pooled prevalence of 10.4% for the general population [28]. While this finding could be linked to respect for local cultural values, it also suggests that most respondents would likely counsel their patients who smoke to quit smoking [36].

Remarkably, only 22.4% of the respondents were physically active, which is lower than the 40.4% obtained among medical doctors in Kano, Nigeria and 46.6% of Australian nurses and midwives [16, 17]. These findings are less than the WHO target of 85% [37], suggesting the

Tab. IV. Workhour feeding characteristics and body mass index (BMI, kg/m^2).

Variables	Mean BMI	BMI < 18.5	BMI 18.5-24.9	BMI 25.0-29.9	BMI ≥ 30	p**
Skip breakfast on a typical workday?						0.442
No	26.1 ± 4.3	4 (2.2)	76 (41.1)	75 (40.5)	30 (16.2)	
Yes	26.1 ± 5.0	5 (3.7)	56 (41.2)	46 (33.8)	29 (21.3)	
Have an official lunchtime in your hospital?						0.321
Yes	26.9 ± 3.9	0 (0)	6 (31.6)	11 (57.9)	2 (10.5)	
No	26.1 ± 4.7	9 (3.3)	110 (40.3)	101 (37.0)	53 (19.4)	
Don't know	25.5 ± 4.2	0 (0)	16 (55.2)	9 (31.0)	4 (13.8)	
How often do you have lunch during workhours?						0.706
Always/often	26.1 ± 4.5	2 (2.2)	41 (45.6)	30 (33.3)	17 (18.9)	
Occasional/never	26.1 ± 4.9	7 (3.0)	91 (39.4)	91 (39.4)	42 (18.2)	
Usual source of lunch during workhours						0.640
Home/skipped lunch	27.0 ± 4.8*	1 (1.3)	30 (39.0)	29 (37.6)	17 (22.1)	
Canteens/shops/meetings	25.8 ± 4.5	8 (3.3)	102 (41.8)	92 (37.7)	42 (17.2)	
What did you have during your last workhours?						0.074
Sugary drinks	26.1 ± 5.1	5 (3.3)	64 (43.0)	46 (30.9)	34 (22.8)	
No sugary drinks[a]	26.1 ± 4.3	4 (2.3)	68 (39.5)	75 (43.7)	25 (14.5)	
Does your hospital have a canteen?						0.507
No	25.7 ± 4.4	2 (6.2)	15 (46.9)	10 (31.3)	5 (15.6)	
Yes	26.2 ± 4.6	7 (2.4)	117 (40.5)	111 (38.4)	54 (18.7)	
How often do you use the hospital canteen?						0.302
Rarely/Never	26.5 ± 4.6	4 (2.7)	60 (40.0)	57 (38.0)	29 (19.3)	
Occasionally	26.3 ± 4.5	3 (2.7)	39 (35.1)	48 (43.2)	21 (18.9)	
At least weekly***	24.9 ± 4.6	2 (3.3)	33 (55.0)	16 (26.7)	9 (15.0)	
Perception about canteen meals						0.439
Healthy	25.9 ± 4.4	6 (2.6)	96 (42.5)	89 (39.4)	35 (15.5)	
Unhealthy	26.5 ± 5.0	3 (3.5)	34 (39.1)	29 (33.3)	21 (24.1)	
Neutral	27.7 ± 3.3	0 (0)	2 (25.0)	3 (37.5)	3 (37.5)	

* Significant; ** Fisher's exact test; [a] Full meal and skipped lunch; *** Daily, twice-, thrice- and more than thrice weekly.

need for appropriate interventions, given that sufficient physical activity has numerous health benefits and physically active doctors are more likely to counsel their patients on physical activity [15].

Furthermore, the overweight and obesity rates (37.7%/18.4%,) found in this study were high and were similar to findings among healthcare workers in Benin City, South-south Nigeria (31.7% /25.2%), Malaysia (33.1%/21.1%), and Saudi Arabia (35%/16%), but were lower than rates found in Lagos, Southwest Nigeria (44.7%/27.3%), and Palestine (39.2%/) [6,10,11,13,19]. It differed slightly from a Ghanaian study, with 39.4% overweight and no obesity [20]. Notably, our finding was higher than a national overweight and obesity prevalence (27.6%/14.5%), a situation similarly recorded in Malaysia but differed from that of Canadian healthcare workers, where their obesity prevalence (8%) was lower than that of the general population [11, 38, 39]. Obesity impacts medical practitioners' health and job performance and has multiple etiological factors such as genetics, lifestyle, environment, and certain disease conditions. The high prevalence among the respondents could be due to interplay factors such as disrupted sleep patterns with chronic work stress, skipping breakfast, snacking on energy-dense, fatty and sugar-loaded foods, prolonged sedentary work hours with insufficient physical activity, and having an averagely higher income, than the general population [10, 31, 32, 40, 41].

In the bivariate analysis and consistent with previous studies, increasing age and male gender were associated with higher mean BMI [10, 42]. But interestingly, the consultants in this study had a higher mean BMI than the non-consultants. This finding could be because they are usually older and earn higher incomes than the non-consultants.

Another notable finding was that respondents who usually brought lunch from home or skipped lunch had significantly higher mean BMI than those who got lunch from their hospital canteens or other sources. The explanation for this association is unclear and requires further investigation.

We found no significant association between the individual healthy behaviours, the healthy behaviours scores and mean BMI, although this is consistent with other studies [6, 13]. However, after including as a priori confounding variables in the final logistic regression

Tab. V. Predictors of obesity and combined overweight and obesity among respondents.

Variables	Obesity (BMI ≥ 30 kg/m²)		Overweight and obesity (BMI ≥ 25 kg/m²)	
	OR (CI)	p-value	OR (CI)	p-value
Age (≥ 39 y)	1.11 (0.46-2.68)	0.816	1.19 (0.58-2.42)	0.635
Sex (female)	1.89 (0.92-3.91)	0.086	0.76 (0.43-1.34)	0.342
Marital status (single)	0.25 (0.07-0.96)	0.043*	0.64 (0.32-1.29)	0.211
Years of practice (< 10 y)	0.39 (0.14-1.10)	0.075	0.43 (0.19-0.96)	0.039*
Duration of current employment (≥ 5 y)	0.59 (0.23-1.50)	0.270	0.62 (0.28-1.35)	0.227
Job categories (non-consultants)	0.76 (0.35-1.66)	0.491	0.96 (0.48-1.93)	0.911
Skip breakfast on typical workday (Yes)	1.53 (0.78-3.01)	0.213	1.31 (0.79-2.19)	0.298
What did you take during last workhours? (No sugary drinks)**	0.45 (0.23-0.88)	0.018*	1.33 (0.78-2.24)	0.293
Source of lunch (hospital canteens and other sources)	0.56 (0.27-1.16)	0.121	0.92 (0.51-1.64)	0.764
Physically active (Yes)	0.58 (0.19-1.78)	0.340	1.54 (0.71-3.34)	0.279
Eat enough fruit/Vegetable (Yes)	0.21 (0.05-0.87)	0.031*	1.81 (0.62-5.23)	0.275
Not currently smoking (Yes)	0.33 (0.02-4.95)	0.421	4.70 (0.46-47.77)	0.191
Healthy behaviour score (≥ 3)	4.12 (0.87-19.47)	0.074	0.54 (0.16-1.79)	0.313
Antihypertensive medication use (Yes)	2.27 (1.00-5.11)	0.049*	4.83 (1.89-12.33)	0.001*
Antidiabetic medication use (Yes)	4.13 (0.75-22.89)	0.105	3.41 (0.37-31.43)	0.279
SBP (< 140 mmHg)	0.30 (0.08-1.09)	0.067	0.42 (0.08-2.12)	0.293

OR: Odds ratio; CI: Confidence interval; * Bold: Significant (p < 0.05).** Full meal or skipped lunch.

model, we found that respondents who consumed enough fruits and vegetables had lower odds of obesity than those who did not, which is consistent with existing evidence [33], but differed from the result of another similar study [42].

Remarkably, refraining from workhour sugary drink consumption also had lower odds of obesity compared to those who had full meals or skipped lunch which aligns with a previous study [32]. Sugary drinks are energy-dense diets, and their habitual consumption has been associated with obesity, suggesting the need for effective educational interventions to discourage this habit and to provide healthy alternatives.

Consistent with other studies, singlehood was associated with decreased odds of obesity compared to being married [9, 13]. It has been hypothesized that married persons have better social support and regularly eat energy-dense diets compared to those who are single and are therefore prone to obesity [43]. In addition, practitioners who were using anti-hypertensive medications were two times and four times more likely to be obese and overweight/obese, respectively. These findings are consistent with another study where having hypertension (elevated systolic blood pressure as demonstrated in this study) increased the risk of overweight and obesity [13].

Finally, practicing for < 10 years lowered the odds of being overweight and obese, which is consistent with a previous study [13], and could be due to younger age, lower income, and fewer years of exposure to work-related stress.

Strengths and limitations

This study had a multicentre and regional design with a probability sampling strategy. It provided valuable data on the link between work hour sugary drink consumption and obesity. However, it had some limitations. The recruitment of practitioners from federal tertiary hospitals limits generalization to other types of hospitals. BMI calculations based on self-reported weight and height may be inaccurate in some cases. Its cross-sectional design precludes the examination of temporal relationships between variables. Also, comparison with similar studies with a homogenous population of medical practitioners was limited due to the paucity of such studies. Future intervention studies are needed to fully understand the effect of workhour feeding practices on obesity. Also, research is required to investigate the relationship between the lifestyle of practitioners in the region and their counselling of patients on related issues.

Conclusions

The obesity and overweight rates were high. Most practitioners feed, and many snack on energy-dense drinks and foods during workhours. Workhour consumption of sugary drinks increased their risk of obesity. Additionally, most practitioners are physically inactive, and many do not consume enough fruits and vegetables. Their overweight and obesity rates exceeded those of the general population. Therefore, stakeholders such as employers, medical unions, and the government should urgently provide effective workplace and community interventions that would encourage behaviour change towards healthy lifestyles. These interventions should include continuous nutritional education, therapeutic programs, healthy meals, and healthy alternatives to energy-dense food and drinks during work hours. The identified predictors of obesity and overweight should be considered when planning these interventions.

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Conflict of interest statement

The authors declare that no conflict of interest exists.

Authors' contributions

MGC: conception, data analysis and first manuscript drafting. MGC, EDN, FFA, IH, GBA, MYB, AI, MAA, SAK, OE, FAG, MJKA: study design and data collection. All authors: data interpretation, manuscript revision and approval for publication. MJKA: supervisor.

References

[1] World Health Organisation. Fact sheets: obesity and overweight. Geneva: World Health Organisation 2021. Available from: www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (Accessed on: 2/12/2023).

[2] Ezzati M, Riboli E. Behavioral and dietary risk factors for noncommunicable diseases. N Engl J Med 2013;369:954-64. https://doi.org/10.1056/NEJMra1203528.

[3] Livingstone KM, McNaughton SA. A Health Behavior Score is Associated with Hypertension and Obesity Among Australian Adults. Obesity (Silver Spring) 2017;25:1610-7. https://doi.org/10.1002/oby.21911.

[4] World Health Organisation. Noncommunicable diseases country profiles 2018 [Internet]. Geneva 2018. Available from: https:// apps.who.int/iris (Accessed on: 4/11/2023).

[5] Khaw KT, Wareham N, Bingham S, Welch A, Luben R, Day N. Combined impact of health behaviours and mortality in men and women: the EPIC-Norfolk prospective population study. PLoS Med 2008;5:e12. https://doi.org/10.1371/journal.pmed.0050012. Erratum in: PLoS Med 2008;5:e70.

[6] Adaja TM, Idemudia OJ. Prevalence of overweight and obesity among health-care workers in University of Benin Teaching Hospital, Benin City, Nigeria. Ann Trop Pathol 2018;9:150-4. https://doi.org/0.4103/atp.atp_30_18.

[7] Chou CF, Johnson PJ. Health disparities among America's health care providers: evidence from the Integrated Health Interview Series, 1982 to 2004. J Occup Environ Med 2008;50:696-704. https://doi.org/10.1097/JOM.0b013e31816515b5.

[8] Luckhaupt SE, Cohen MA, Li J, Calvert GM. Prevalence of obesity among U.S. workers and associations with occupational factors. Am J Prev Med 2014;46:237-48. https://doi.org/10.1016/j.amepre.2013.11.002.

[9] Dankyau M, Shu'aibu JA, Oyebanji AE, Mamven OV. Prevalence and correlates of obesity and overweight in healthcare workers at a tertiary hospital. J Med Trop 2016;18:55-9. https://doi.org/10.4103/2276-7096.188533.

[10] Iwuala SO, Ayankogbe OO, Olatona FA, Olamoyegun MA, OkparaIgwe U, Sabir AA, Fasanmade OA. Obesity among health service providers in Nigeria: danger to long term health worker retention? Pan Afr Med J 2015;22:1. https://doi.org/10.11604/pamj.2015.22.1.5586.

[11] Kunyahamu MS, Daud A, Jusoh N. Obesity among Health-Care Workers: Which Occupations Are at Higher Risk of Being Obese? Int J Environ Res Public Health 2021;18:4381. https://doi.org/10.3390/ijerph18084381.

[12] Lee DJ, Fleming LE, Gómez-Marín O, LeBlanc WG, Arheart KL, Caban AJ, Christ SL, Chung-Bridges K, Pitman T. Morbidity ranking of U.S. workers employed in 206 occupations: the National Health Interview Survey (NHIS) 1986-1994. J Occup Environ Med 2006;48:117-34. https://doi.org/10.1097/01.jom.0000199520.23232.26.

[13] Younis J, Jiang H, Fan Y, Wang L, Li Z, Jebril M, Ma M, Ma L, Ma M, Hui Z. Prevalence of overweight, obesity, and associated factors among healthcare workers in the Gaza Strip, Palestine: A cross-sectional study. Front Public Health 2023;11:1129797. https://doi.org/10.3389/fpubh.2023.1129797.

[14] Howe M, Leidel A, Krishnan SM, Weber A, Rubenfire M, Jackson EA. Patient-related diet and exercise counseling: do providers' own lifestyle habits matter? Prev Cardiol 2010;13:180-5. https://doi.org/10.1111/j.1751-7141.2010.00079.x.

[15] Lobelo F, de Quevedo IG. The Evidence in Support of Physicians and Health Care Providers as Physical Activity Role Models. Am J Lifestyle Med 2016;10:36-52. https://doi.org/10.1177/1559827613520120.

[16] Perry L, Xu X, Gallagher R, Nicholls R, Sibbritt D, Duffield C. Lifestyle Health Behaviors of Nurses and Midwives: The 'Fit for the Future' Study. Int J Environ Res Public Health 2018;15:945. https://doi.org/10.3390/ijerph15050945.

[17] Michael GC, Grema BA, Aliyu I, Suleiman AK, Tanimu ST. Physical activity profile of medical practitioners: A preliminary cross-sectional study in Kano, Northwest Nigeria. Niger J Med 2020;29:693-700. https://doi.org/10.4103/NJM.NJM_78_20.

[18] Kunene SH, Taukobong NP. Dietary habits among health professionals working in a district hospital in KwaZulu-Natal, South Africa. Afr J Prim Health Care Fam Med 2017;9:e1-5. https://doi.org/10.4102/phcfm.v9i1.1364.

[19] Al Hazmi TM, Alghamdi A, Abdulmajeed I. Eating Habits among Healthcare Providers during Working Hours at National Guard Health Affairs-Riyadh, Saudi Arabia. Int J Med Res Health Sci 2018;7:1-14.

[20] Nsiah-Asamoah1 CNA, Amoasi D, Setorglo J. Dietary practices of health professionals during working hours in a tertiary referral teaching hospital in Ghana: a neglected vulnerable group. Eur J Nutr Food Saf 2021;13:82-97. https://doi.org/10.9734/ejnfs/2021/v13i530422.

[21] Lemaire JB, Wallace JE, Dinsmore K, Lewin AM, Ghali WA, Roberts D. Physician nutrition and cognition during work hours: effect of a nutrition based intervention. BMC Health Serv Res 2010;10:241. https://doi.org/10.1186/1472-6963-10-241.

[22] Winston J, Johnson C, Wilson S. Barriers to healthy eating by National Health Service (NHS) hospital doctors in the hospital setting: results of a cross-sectional survey. BMC Research Notes 2008;1:69. https://doi.org/10.1186/1756-0500-1-69.

[23] Faugier J, Lancaster J, Pickles D, Dobson K. Barriers to healthy eating in the nursing profession: Part 1. Nurs Stand 2001;15:33-6. https://doi.org/10.7748/ns2001.05.15.36.33.c3030.

[24] Faugier J, Lancaster J, Pickles D, Dobson K. Barriers to healthy eating in the nursing profession: Part 2. Nurs Stand. 2001 May 30-Jun 5;15(37):33-5. https://doi.org/10.7748/ns2001.05.15.37.33.c3033.

[25] World Health Organization. Obesity and overweight. Geneva: World Health Organization 2016. Available at: http://www.who.int/mediacentre/ factsheets/fs311/en/ (Accessed on: 20/11/2023).

[26] Meriwether RA, McMahon PM, Islam N, Steinmann WC. Physical activity assessment: validation of a clinical assessment tool. Am J Prev Med 2006;31:484-91. https://doi.org/10.1016/j.amepre.2006.08.021.

[27] Iloh G. Amadi AN, Okafor GOC, Ikwudinma AO, Odu FU, Godswill-Uko EU. Adherence to Lifestyle Modifications among Adult Hypertensive Nigerians with Essential Hypertension in a Primary Care Clinic of a Tertiary Hospital in Resource-poor Environment of Eastern Nigeria. Br J Med Med Res 2014;4:3478-90. https://doi.org/10.9734/BJMMR/2014/9439.

[28] Adeloye D, Auta A, Fawibe A, Gadanya M, Ezeigwe N, Mpazanje RG, Dewan MT, Omoyele C, Alemu W, Harhay MO, Adewole IF. Current prevalence pattern of tobacco smoking in Nigeria: a systematic review and meta-analysis. BMC Public Health 2019;19:1719. https://doi.org/10.1186/s12889-019-8010-8.

[29] Gopinath B, Liew G, Flood VM, Joachim N, Burlutsky G, Mitchell P. Combined influence of poor health behaviours on the prevalence and 15-year incidence of age-related macular degeneration. Scientific Reports 2017;7:4359. https://doi.org/10.1038/s41598-017-04697-3.

[30] Ressel GW; NHLBI. NHLBI releases new high blood pressure guidelines. Am Fam Physician 2003;68:376-9.

[31] Ma X, Chen Q, Pu Y, Guo M, Jiang Z, Huang W, Long Y, Xu Y. Skipping breakfast is associated with overweight and obesity: A systematic review and meta-analysis. Obes Res Clin Pract 2020;14:1-8. https://doi.org/10.1016/j.orcp.2019.12.002.

[32] Rouhani MH, Haghighatdoost F, Surkan PJ, Azadbakht L. Associations between dietary energy density and obesity: A systematic review and meta-analysis of observational studies. Nutrition 2016;32(:1037-47. https://doi.org/10.1016/j.nut.2016.03.017.

[33] Arnotti K, Bamber M. Fruit and Vegetable Consumption in Overweight or Obese Individuals: A Meta-Analysis. West J Nurs Res 2020;42:306-314. https://doi.org/10.1177/0193945919858699.

[34] Sarna L, Bialous SA, Nandy K, Antonio AL, Yang Q. Changes in smoking prevalences among health care professionals from 2003 to 2010-2011. JAMA 2014;311:197-9. https://doi.org/10.1001/jama.2013.284871.

[35] Al Shahrani AS, Almudaiheem NR, Bakhsh EM, Sarhan NT, Aldossari FS, Bin Huzeim BA. Understanding Smoking Behavior among Physicians in Riyadh, Saudi Arabia: A Cross-Sectional Study. Tob Use Insights 2021;14:1179173X211006652. https://doi.org/10.1177/1179173X211006652.

[36] Sotiropoulos A, Gikas A, Spanou E, Dimitrelos D, Karakostas F, Skliros E, Apostolou O, Politakis P, Pappas S. Smoking habits and associated factors among Greek physicians. Public Health 2007;121:333-40. https://doi.org/10.1016/j.puhe.2006.10.013.

[37] World Health Organisation. Fact sheets: Obesity and overweight. Geneva: World Health Organisation 2021. Available at: www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (Accessed on: 30/11/2023).

[38] Chukwuonye II, Ohagwu KA, Ogah OS, John C, Oviasu E, Anyabolu EN, et al. Prevalence of overweight and obesity in Nigeria: Systematic review and meta-analysis of population-based studies. PLOS Glob Public Health 2022;2:e0000515. https://doi.org/10.1371/journal.pgph.0000515.

[39] Frank E, Segura C. Health practices of Canadian physicians. Can Fam Physician 2009;55:810-1.

[40] McHill AW, Wright KP Jr. Role of sleep and circadian disruption on energy expenditure and in metabolic predisposition to human obesity and metabolic disease. Obes Rev 2017;18(Suppl 1:15-24). https://doi.org/10.1111/obr.12503.

[41] Hassapidou M, Papadopoulou SK, Vlahavas G, Kapantais E, Kaklamanou D, Pagkalos I, Kaklamanou M, Tzotzas T. Association of physical activity and sedentary lifestyle patterns with obesity and cardiometabolic comorbidities in Greek adults: data from the National Epidemiological Survey. Hormones (Athens) 2013;12:265-74. https://doi.org/10.14310/horm.2002.1410.

[42] Guo X, Gong S, Chen Y, Hou X, Sun T, Wen J, Wang Z, He J, Sun X, Wang S, Feng X, Tian X. Lifestyle behaviors and stress are risk factors for overweight and obesity in healthcare workers: a cross-sectional survey. BMC Public Health 2023;23:1791. https://doi.org/10.1186/s12889-023-16673-w.

[43] Tzotzas T, Vlahavas G, Papadopoulou SK, Kapantais E, Kaklamanou D, Hassapidou M. Marital status and educational level associated to obesity in Greek adults: data from the National Epidemiological Survey. BMC Public Health 2010;10:732. https://doi.org/10.1186/1471-2458-10-732.

[44] Hulsegge G, van Mechelen W, Paagman H, Proper KI, Anema JR. The moderating role of lifestyle, age, and years working in shifts in the relationship between shift work and being overweight. Int Arch Occup Environ Health 2020;93:697-705. https://doi.org/10.1007/s00420-020-01519-4.

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Non-comunicable Diseases

Balance measures of mini and brief balance evaluation system tests for Iranian population

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Keywords

Balance • Mini-BESTest • Brief-BESTest • Normative values

Summary

Introduction. *Falling is a serious problem for all ages. There are several tests to assess balance. Mini-BESTest and brief-BESTest are balance tests for which there are no normative values for Iranian people. We aimed to provide the normative values of mini-BESTest and brief-BESTest among healthy Iranian adults.*
Methods. *A cross-sectional study was designed. Three hundred healthy adults (150 males and 150 females) in six age groups (18-29, 30-39, 40-49, 50-59, 60-69, +70 years) completed the tests using Persian mini-BESTest and brief-BESTest. Normative values were calculated for age groups.*
Results. *Normative values of mini-BESTest and brief- BESTest decreased significantly with age (from 27 to 21.9 for mini-BESTest and from 22.9 to 15.4 for brief BESTest). There were no significant differences between genders except for females in 30-39 and 40-49 years age groups which scored better on brief-BESTest and mini-BESTest, respectively. Males had significantly scored better in brief- BESTest in 60-69 and ≥ 70 age groups.*
Conclusions. *The normative values of the mini-BESTest and brief-BESTest provided for healthy Iranian adults can help clinicians when assessing subjects with balance dysfunction.*

Introduction

Balance is the ability of the individual to control their posture. The balance system is essential for daily activities, maintaining posture, and moving in different conditions [1]. Balance is a complex phenomenon resulting from the interaction between skeletal, neuromuscular, and sensory systems [2]. Problems in sensory, cognitive, or motor systems can cause balance deficits [1]. Balance deficits reduce physical function, leading to falls, fall-related injuries, and activity restriction [3].
Falling is a serious problem for all ages. In the United States, about 42% of medically consulted injuries were due to fall in 2010 [4], and one-third of fall injuries occurred in various age groups [5]. Orthopedic injuries like fractures, dislocations, sprains are the most common fall-related injuries [5, 6]. The mortality rate increases with age, and falling directly contributes to about 1800 deaths [7].
The annual cost of fall-related injuries is about 471$ per person in the United States and increases with age from 238$ per person for the 18-24 years age group to 1186$ for the +75 years age group [5]. Hence, balance assessment is important to detect dysfunctions and determine the treatments' effectiveness [3].
Timed Up & Go (TUG) test and Berg Balance Scale (BBS) are the most commonly used tools to assess balance. The TUG test is a functional balance test that is sensitive and specific in identifying community-dwelling adults at risk of fall [8] but cannot discriminate between fallers and non-fallers in high functioning elderly [9]. The BBS has excellent inter and intra-rater reliability [10] but suffers from floor and ceiling effects [11].
Balance Evaluation System Test (BESTest) developed in 2009 consists of 36 items and six sections, including biomechanical constraints, stability limits/vertically, anticipatory postural adjustment, postural response, sensory orientation, and stability in gait [12]. Hence, BESTest can identify the system responsible for the probable balance deficit, which can help direct the treatment specifically on the patient's problem [12]. A recent study showed that the BESTest scores significantly differ between fallers and non-fallers [13]. BESTest also has excellent reliability [1, 14-17] and good to excellent validity in different populations [12-15]. However, the BESTest takes about 30 minutes to perform in the clinical setting. Therefore, a shorter version of BESTest appeared in 2010 called the mini-BESTest [18].
Mini-BESTest assesses the dynamic balance and consists of 14 items of BESTest, which are more practical and psychometrically useful [18]; however, its total score has a good to excellent correlation with BESTest total score and predicts 58.8% to 68% of the variance in dynamic balance [18, 19]. The Mini-BESTest takes about 10-15 minutes to perform, increasing its feasibility [18]. The Mini-BESTest has higher sensitivity

and specificity than BESTest in predicting people with a history of falls [17]. It also has excellent test-retest and inter-rater reliability [14, 19, 21, 22], good to excellent correlation with the BBS in various populations [21-24], and excellent responsiveness in patients with different balance disorders [21, 25].

Although mini-BESTest could be administered in a shorter duration, there was a need for a shorter version of the test for use in the clinics. In addition, the mini-BESTest only assesses the dynamic balance, and biomechanical constraints and limits of stability/vertically systems are not evaluated in mini-BESTest, which is against the theoretical basis of BESTest. In order to retain the theoretical basis of the BESTest, the brief-BESTest developed, which is another shorter version of BESTest.

Brief-BESTest contains six items that are representative of each section of BESTest [26]. Brief-BESTest takes less time to perform than mini-BESTest and has excellent inter-rater reliability, even more reliable than mini-BESTest and BESTest, and excellent test-retest reliability [27]. Brief-BESTest has comparable sensitivity and specificity to mini-BESTest and BESTest in discriminating patients with a fall history [27]; however, it has a limited sensitivity to change [28]. Brief-BESTest can discriminate fallers and non-fallers in the elderly population; however, this ability diminishes in younger populations [29].

Normative values of mini-BEST and brief-BESTest can be used as reference range to help clinicians and researchers to interpret tests results in people with balance dysfunction. There are normative values of BESTest, mini-BESTest, and brief- BESTest reported for healthy Canadian adults aged ≥ 50 years old [30]; however, there is no normative data for other age groups. Moreover, in the previous study, a small sample size of 20 people in each age group was included [30]. The lack of a larger study with a normal range for all age groups makes it difficult to interpret the tests' results restricting the clinical utility of mini-BEST and brief-BESTest. Therefore, the present study aimed to determine the normative values of mini-BESTest and brief-BESTest in healthy Iranian adults across age groups and genders.

Materials and methods

Design

A cross-sectional study was designed. Data were collected in ten months from August 2015 to June 2016 in Tehran. The ethics committee of the Tehran University of medical sciences approved the study protocol (IR.TUMS.REC.1394.1512).

Subjects

Healthy community-dwelling adults who were 18 years of age and older were recruited from public places such as mosques, universities, factories, parks, *etc.* The purpose of the study was described to participants before taking part in the study, and oral consent was obtained from all participants. A sample size of at least 20 people in each age group was reported in a previous study [30], then we targeted a sample size of 300 subjects in six age groups (18-29, 30-39, 40-49, 50-59, 60-69 and ≥ 70) with 25 men and 25 women in each age group.

The inclusion criteria were: 1) age ≥ 18 years; 2) living independently in the community; 3) ability to speak and read Persian; 4) ability to follow commands; 5) ability to walk 6 meters without any help; 6) giving consent; 7) no history of faint, vertigo or dizziness or current use of medications which can cause dizziness; 8) no past or current history of any medical condition which can affect the balance including neurological diseases such as Parkinson's disease or multiple sclerosis, musculoskeletal disorders such as arthritis, and vestibular disorders.

Instruments

Mini-BESTest consists of 14 items scored from 0 to 2. The total score is the sum of all item scores from 0 to 28 [18, 31]. Mini-BESTest is translated to Persian, and its Persian version is reliable and valid for evaluating balance among Iranian people [32, 33].

Brief- BESTest has six sections, each with one item. The items 'Stand on one leg' and "Compensatory step lateral' are scored bilaterally. Each item is being scored on a scale from 0 to 3. All eight items' scores are summed to obtain the total score ranging from 0 to 24 [26] (Tab. I). Persian version of Brief-BESTest is also a reliable and valid tool for balance evaluation in Iranian people [33, 34]. For both Mini-BESTest (www.bestest.us) and Brief-BESTest, we used the Persian versions for scoring and instructing the participants [33].

Procedure

Six raters participated and collected the data that five of them were medical students, and one was a physiotherapist. All raters underwent training using the BESTest training DVD provided by Professor Fay B. Horak under the supervision of SN, an expert, experienced physiotherapist, and Professor. Under the supervision of SN, raters practiced the tests procedure and scoring until they reached an agreement on tests performance and scoring.

We selected several public places such as universities and mosques in Tehran and recruited the participants from these places. In order to facilitate the participation in the study, we prepared a room in each of these places, which was separate from the working environment and crowded environments, and performed the tests in these rooms. After obtaining oral consent, participants' demographic information such as age, gender, weight, height, educational level, and the job was recorded. In order to test the participants, one rater read the Persian instruction of each item for the subject and asked the subject to perform the items. Then, the rater scored each item immediately after the subject's performance. The items 'Hip/trunk lateral strength' and 'Functional reach forward' from brief-BESTest were first performed by the subjects, and then, the mini-BESTest items were tested.

Tab. I. Sections and related items in Mini-BESTest and Brief-BESTest.

Test	Section	Item
Mini-BESTest (scores range from 0 to 28)	Anticipatory (scores range from 0 to 6)	Sit to Stand*
		Rise to toes*
		Stand on one leg*
	Reactive postural control (scores range from 0 to 6)	Compensatory stepping correction- Forward*
		Compensatory stepping correction- Backward*
		Compensatory stepping correction- lateral*
	Sensory orientation (scores range from 0 to 6)	Stance (Feet together); eyes open, firm surface*
		Stance (Feet together); eyes closed, foam surface*
		Inline- eyes closed*
	Dynamic gait (scores range from 0 to 10)	Change in gait speed*
		Walk with head turns- horizontal*
		Walk with pivot turns*
		Step over obstacles*
		Timed Up & Go with dual task*
Brief BESTest (scores range from 0 to 24)	Biomechanical constraints (scores range from 0 to 3)	Hip/trunk lateral strength**
	Stability limits (scores range from 0 to 3)	Functional reach forward**
	Transitions–anticipatory postural adjustment (scores range from 0 to 6)	Stand on one leg-left and right***
	Reactive postural response (scores range from 0 to 6)	Compensatory stepping-lateral, left and right***
	Sensory orientation (scores range from 0 to 3)	Stance with eyes closed, on foam surface**
	Stability in gait (scores range from 0 to 3)	Timed "Up & Go" test**

*Scores range from 0 to 2. **Scores range from 0 to 3. ***These items are scored bilaterally, and scores range from 0 to 6.
Note: Total scores of Mini-BESTest and Brief-BESTest, and their sections scores are calculated by the sum of all related items' scores.

Data Analysis

Descriptive statistics of mean and standard deviation (SD) were calculated for continuous variables. The Kolmogorov-Smirnov test was used to assess whether the distribution of mini-BEST and brief-BESTest total scores and their subscales' scores are normal. Since these variables were not distributed normally ($p < 0.05$), we used the Kruskal-Wallis test to determine the differences between age groups, and median and interquartile range (IQR) were calculated for these variables. If there was a significant difference between age groups, posthoc analysis was performed to assess the differences between groups. The Mann-Whitney U test was used to determine whether there is a significant difference in mini-BESTest and brief-BESTest total scores and their subscales' scores between genders. SPSS software (version 16 for windows, SPSS inc, Chicago, Illinois) was used for all analyses. We considered $p \leq 0.05$ as statistically significant.

Results

Three hundred healthy adults with a mean age of 49.0 years (SD = 17.8) participated in this study. For each age group, 50 subjects (25 males and 25 females) were assessed. The demographic data of each age group are shown in Table II.

Mini-BESTest

Participants' scores decreased significantly across all mini-BESTest total scores and all of its subscales' scores ($p < 0.05$). Adults who were 70 years or older had significantly lower scores than other age groups across all subscales and the mini-BESTest total score ($p < 0.05$), except in the sensory orientation subscale, in which there was no significant difference between ≥ 70 years age group and other age groups. Also, there was no significant difference between ≥ 70 years and 60-69 years age group in the dynamic gait subscale ($p = 1$). Figure 1 shows the age-related decline in the mini-BESTest score.

Males had significantly higher anticipatory subscale scores than females in the 50-60 and 60-69 age groups ($p < 0.05$). Also, 60-69 years participants had significantly lower scores in this subscales than those who were 18-39 years ($p < 0.05$). Females had significantly higher scores than males in reactive postural control subscales, except in 50-59 years ($p = 0.494$) and ≥ 70 years ($p = 0.093$) groups. Also, adults who were 18-29 years had significantly higher scores than those who were 60-69 years ($p = 0.026$). In the sensory orientation, males had significantly higher scores than females in the 60-69 years age group ($p = 0.039$). In contrast, in the dynamic gait subscale females had significantly higher scores than males in the 40-49 years group ($p = 0.005$). In the dynamic gait subscale, adults who were 60-69 years had significantly lower scores than younger adults ($p < 0.05$). Normative values of mini-BESTest were not significantly different between males

Tab. II. Demographic data by age.

	Age groups (year)													
	18-29 (n = 50)		30-39 (n = 50)		40-49 (n = 50)		50-59 (n = 50)		60-69 (n = 50)		≥ 70 (n = 50)		Total (n = 300)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (year)	22.3	2.2	33.6	2.7	45.3	2.7	54.4	3.0	64.1	2.4	74.3	3.9	49.0	17.8
Weight (kg)	66.9	13.6	71.1	14.8	71.1	12.4	72.4	12.8	73.0	11.1	68.9	11.7	70.5	12.8
Height (cm)	169.9	9.7	168.3	8.4	166.9	8.7	166.4	9.7	165.3	8.3	166.0	9.0	167.1	9.0
Body mass index (kg/m^2)	23	3.1	25.0	4.6	25.4	3.7	26.1	3.6	26.7	3.7	24.9	3.6	25.2	3.9

SD: standard deviation.

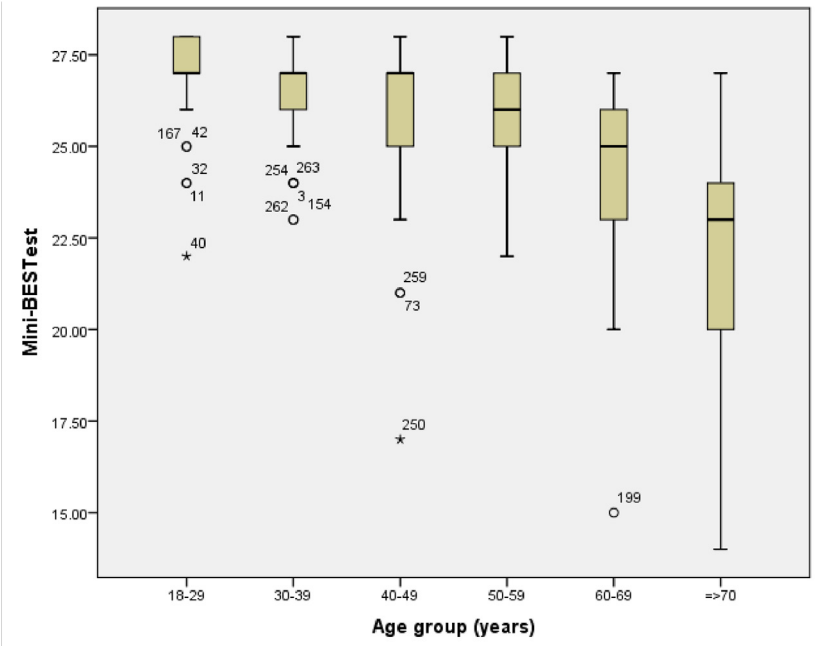
and females across age groups except for the 40-49 age group in which females had performed better ($p = 0.022$). Also, adults who were 60-69 years had significantly lower scores than those who were 18-49 years $p < 0.05$). Also, those who were 18-29 years had significantly higher scores than those who were 50-59 years ($p = 0.001$). There was no other significant difference between age groups and genders regarding the mini-BEST total score and its subscales scores ($p > 0.05$) (Tab. III).

Mini-BESTest total score and all its subscale scores based on participants' occupations and educational levels are shown in Table IV. There were significant differences between all educational groups in the anticipatory subscale, with people with higher educational levels had significantly higher scores. Also, people with a degree higher than a diploma had higher scores in mini-BESTest, reactive postural control, and dynamic gait subscale than people with lower educational levels ($p < 0.05$). Also, people with an educational degree of lower than diploma had lower scores in the sensory orientation subscale than people with higher educational degrees ($p < 0.05$). There were also significant differences between occupations across mini-BESTest total score and all its subscales' scores ($p < 0.05$).

Brief-BESTest

Brief-BESTest total scores and all its subscales decreased significantly with age ($p < 0.05$). Participants who were 70 years or older had significantly lower scores than other age groups in transitions–anticipatory postural adjustment, reactive postural response, and stability in gait subscales ($p < 0.05$). These participants also had lower scores than participants who were younger than 60 years in biomechanical constraints, stability limits subscales, and the brief-BESTest total score ($p < 0.05$), with the only exception, was in the stability limits subscale, in which there was no significant difference between adults who were 70 years or older and participants who were 40 to 49 years ($p = 0.094$). Figure 2 shows the age-related decline in the brief-BESTest score.

Fig. 1. Mini-BESTest total scores across age groups. Middle thick line, median; bottom box, first quartile; upper box, third quartile; lower whisker, minimum (excluding outliers and extremes); upper whisker, maximum (excluding outliers and extremes); circle, outlier; star, extreme value. Numbers beside the stars and circles indicate the code of the subject.



Tab. III. Normative values of balance Mini-BESTest and Brief-BESTest in healthy Iranian subjects (n = 300).

Tests	Total	18-29 years				30-39 years				40-49 years				50-59 years				60-69 years				≥ 70 years				p-value
		Total (N = 50)	Male (N = 25)	Female (N = 25)	p-value	Total (N = 50)	Male (N = 25)	Female (N = 25)	p-value	Total (N = 50)	Male (N = 25)	Female (N = 25)	p-value	Total (N = 50)	Male (N = 25)	Female (N = 25)	p-value	Total (N = 50)	Male (N = 25)	Female (N = 25)	p-value	Total (N = 50)	Male (N = 25)	Female (N = 25)	p-value	
Anticipatory	6 (1)	6 (0)	6 (0)	6 (0)	0.556	6 (0)	6 (1)	6 (0)	0.151	6 (1)	6 (1)	6 (1)	0.921	6 (1)	6 (0)	6 (1)	0.009	5 (1)	6 (1)	5 (1.5)	0.005	4 (1.25)	5 (1.5)	4 (1.5)	0.285	< 0.001
Reactive postural control	6 (1)	6 (0)	6 (1)	6 (0)	0.012	6 (0)	6 (1)	6 (0)	< 0.001	6 (1)	6 (1.5)	6 (0)	0.018	6 (1)	6 (1)	6 (1)	0.494	5 (2)	5 (2)	6 (1)	0.042	4 (2.25)	5 (1.5)	3 (4)	0.093	< 0.001
Sensory orientation	6 (0)	6 (0)	6 (0)	6 (0)	0.153	6 (0)	6 (0)	6 (0)	1	6 (0)	6 (0)	6 (0)	0.317	6 (0)	6 (0)	6 (0)	1	6 (0)	6 (0)	6 (1)	0.039	6 (0)	6 (0)	6 (0)	0.174	0.042
Dynamic gait	9 (1)	10(1)	10 (1)	10 (1)	0.885	9 (1)	10 (1)	9 (0.5)	0.082	9(2)	9 (1)	9 (1)	0.005	9 (1)	9 (1)	9 (0.5)	0.814	8 (1)	8 (0.5)	9 (1.5)	0.336	8 (1)	8 (1)	8 (2)	0.297	< 0.001
Mini-BESTest	26 (3)	27 (1)	27 (2)	27 (1)	0.392	27 (1.25)	27 (1.5)	27 (2)	0.252	27 (2)	26 (3)	27 (1)	0.022	26 (2)	26 (1.5)	26 (2)	0.29	25 (3)	25 (3)	25 (3)	0.882	23 (4)	23 (3)	22 (5)	0.213	< 0.001
Biomechanical constraints	3 (1)	3 (1)	3 (1)	3 (0)	0.067	3 (1)	2 (1)	3 (0)	< 0.001	3 (1)	3 (1)	3 (1)	0.937	3 (1)	3 (1)	3 (1.5)	0.536	2 (2)	2 (2)	2 (3)	0.565	1 (2)	2 (3)	1 (1.5)	0.636	< 0.001
Stability limits	2 (1)	3 (1)	3 (0.5)	3 (1)	0.533	2 (1)	2 (1)	2 (1)	0.777	2 (1)	2 (1)	2 (1)	0.319	3 (1)	3 (1)	2 (1)	0.112	2 (0)	2 (1)	2 (0.5)	0.005	2 (0)	2 (0.5)	2 (1)	0.003	< 0.001
Transitions-anticipatory postural adjustment	6 (2)	6 (0)	6 (0.5)	6 (0)	0.01	6 (0)	6 (0)	6 (0)	0.76	6 (2)	6 (2)	6 (1.5)	0.811	6 (2)	6 (1)	5 (3)	0.031	4 (3.25)	5 (2)	4 (4)	0.024	2.5 (3)	4 (2.5)	2 (3)	0.005	< 0.001
Reactive postural response	6 (1)	6 (0)	6 (0)	6 (0)	0.293	6 (0)	6 (1)	6 (0)	0.005	6 (0)	6 (1)	6 (0)	0.089	6 (0)	6 (0.5)	6 (0)	0.989	6 (1)	6 (1)	6 (0.5)	0.327	5 (4)	5 (2)	2 (4)	0.006	< 0.001
Sensory orientation	3 (0)	3 (0)	3 (0)	3 (0)	0.153	3 (0)	3 (0)	3 (0)	1	3 (0)	3 (0)	3 (0)	0.556	3 (0)	3 (0)	3 (0)	0.317	3 (0)	3 (0)	3 (0)	0.336	3 (0)	3 (0)	3 (0.5)	0.053	0.022
Stability in gait	3 (0)	3 (0)	3 (0)	3 (0)	1	3 (0)	3 (0)	3 (0)	0.153	3 (0)	3 (0)	3 (0)	0.317	3 (0)	3 (0)	3 (0)	0.077	3 (0)	3 (0)	3 (0.5)	0.044	3 (1)	3 (0.5)	2 (1)	0.004	< 0.001
Brief-BESTest	22 (4)	23 (1)	23 (3.5)	24 (1)	0.245	23 (1.5)	22 (2)	23 (1)	0.005	22 (2)	22 (3.5)	22 (2)	0.89	22 (4)	23 (2.5)	21 (7)	0.108	20 (4.25)	20 (3.5)	18 (6.5)	0.037	15 (7)	18 (4.5)	13 (4)	< 0.001	< 0.001

Values are reported as median (IQR)

Tab. IV. Normative values of balance Mini-BESTest and Brief-BESTest based on occupation and educational level.

	Educational level				Occupation					
	Lower than diploma	Diploma	Higher than diploma	p-value	Student	Clerk	Worker	Housewife	Other	p-value
Anticipatory	5 (2)	6 (1)	6 (0)	< 0.001	6 (0)	6 (0)	6 (1)	5 (2)	6 (1)	< 0.001
Reactive postural control	6 (2)	6 (2)	6 (1)	0.008	6 (0)	6 (1)	6 (1)	6 (2)	5 (2)	< 0.001
Sensory orientation	6 (0)	6 (0)	6 (0)	< 0.001	6 (0)	6 (0)	6 (0)	6 (0)	6 (0)	0.023
Dynamic gait	8 (1)	9 (1)	9 (1)	< 0.001	10 (1)	9 (1)	9 (1.5)	9 (1)	8 (1)	< 0.001
Mini-BESTest	24 (3.75)	26 (4)	27 (2)	< 0.001	28 (1)	27 (1)	26 (2.5)	25 (3)	25 (4)	< 0.001
Biomechanical constraints	2 (1)	2 (1)	3 (1)	< 0.001	3 (0)	3 (1)	2 (1)	2 (2)	3 (1)	< 0.001
Stability limits	2 (0)	2 (1)	3 (1)	< 0.001	3 (1)	2 (1)	2 (1)	2 (0)	2 (1)	< 0.001
Transitions–anticipatory postural adjustment	4 (4)	6 (2)	6 (1)	< 0.001	6 (0)	6 (0.25)	6 (2)	4 (4)	6 (2)	< 0.001
Reactive postural response	6 (2)	6 (1)	6 (0)	< 0.001	6 (0)	6 (0)	6 (0)	6 (2)	6 (1)	0.001
Sensory orientation	3 (0)	3 (0)	3 (0)	0.006	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)	0.088
Stability in gait	3 (1)	3 (0)	3 (0)	< 0.001	3 (0)	3 (0)	3 (0)	3 (1)	3 (0)	< 0.001
Brief-BESTest	18 (6)	22 (4.5)	23 (3)	< 0.001	24 (1)	23 (2)	22 (2.5)	17 (7.5)	21 (4)	< 0.001

Values are reported as median (IQR)

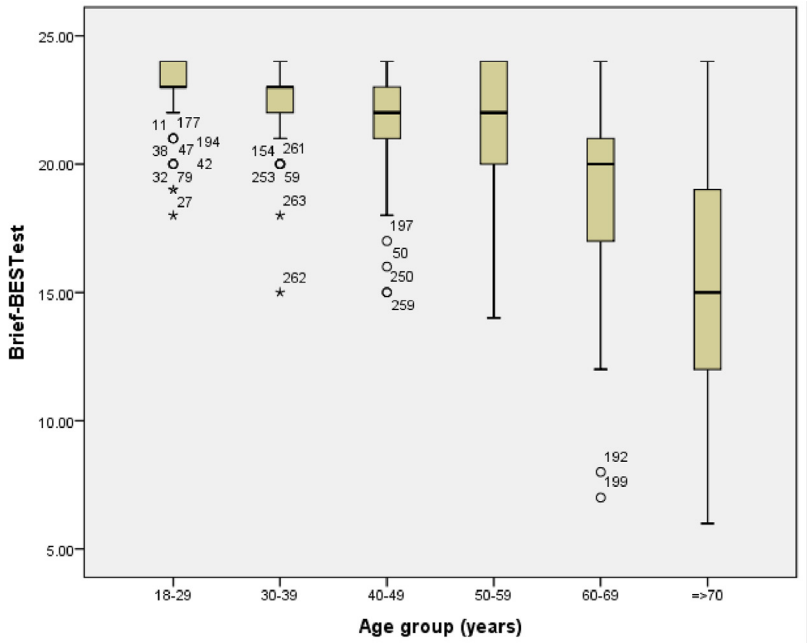
Males had significantly lower scores in the biomechanical constraints subscale than females in the 30-39 years age group ($p < 0.001$). Also, 60-69 years participants had lower scores than those who were younger than 50 years in this subscale ($p < 0.05$). Females who were 60 years or older had lower scores than males in the stability limits subscale than the males in the same age groups ($p < 0.05$). Participants who were in the 18-29 years age group had significantly higher scores than those in the 40-49 and 60-69 years age group ($p < 0.05$), and participants who were 60-69 years had significantly lower scores than adults in the 30-39 and 50-59 years age groups ($p < 0.05$). Males who were 50 years or older had significantly higher scores in the transitions-anticipatory postural adjustment subscale than females in the same age group ($p < 0.05$). In contrast, females had higher scores than males in the 18-29 age group ($p = 0.01$). For this subscale, adults who were 60-69 years had significantly lower scores than those who were 18-49 years ($p < 0.05$). Males had significantly lower scores in the reactive postural response subscale than females in the 30-39 years age group ($p = 0.005$), but they had higher scores than females in the ≥ 70 years age group ($p = 0.006$). Females who were 60 years or older had significantly lower scores in the stability in gait subscale than males in the same age groups ($p < 0.05$). In the 30-39 age group, females had performed better than males on brief-BESTest ($p = 0.005$). Males had instead performed better on brief- BESTest in 60-69 and ≥ 70 age groups ($p < 0.05$). Brief-BESTest scores were significantly lower in the adults who were 60 or older than other age groups ($p < 0.05$). Also, those who were 50-59 years had significantly lower scores than participants who were 18-29 years ($p = 0.05$). There was no other significant difference between age groups and genders regarding the brief-BEST total score and its subscales scores ($p > 0.05$).

Brief-BESTest total score and all its subscale scores based on participants' occupations and educational level are shown in Table IV. There were significant differences between people with different educational levels in the brief-BESTest total score, biomechanical constraints, and stability limits subscales, as people with higher educational levels had higher scores ($p < 0.05$). Also, People with the educational degree of lower than diploma had lower scores in the transitions-anticipatory postural adjustment, sensory orientation, and stability in gait subscales than people with higher educational levels ($p < 0.05$). People with an educational level of higher than diploma had higher scores in the reactive postural response subscale than people with lower educational levels ($p < 0.05$). There were also significant differences between occupations across brief-BESTest total score and all its subscales' scores ($p < 0.05$), except sensory orientation subscale ($p = 0.088$).

Discussion

The present study provided the normative values of mini-BESTest and brief-BEST test scores for healthy Iranian adults. In addition, we found that the mini-BESTest and brief-BEST test scores decreased as the age increased. There were no significant differences between genders

Fig. 2. Brief-BESTest total scores across age groups. Middle thick line, median; bottom box, first quartile; upper box, third quartile; lower whisker, minimum (excluding outliers and extremes); upper whisker, maximum (excluding outliers and extremes); circle, outlier; star, extreme value. Numbers beside the stars and circles indicate the code of the subject.



on mini-BESTest and brief-BEST test scores except that the young females performed better than young males, and older males performed better than the older females on brief- BESTest. As far as we know, this is the first study that provided normative values for the mini-BESTest and brief BEST test in the healthy Iranian population.

Our study found that the ability of the participants to maintain their balance decreased with increases in age, which is in line with previous studies [30, 35-37]. The age-dependent decrease in balance performance was especially apparent in participants who were ≥ 60 years old [36]. Decreases in balance with increased age might be explained by age-related declines in various sensory (vision, vestibular), neuromusculoskeletal and somatosensory systems [38-44].

Normative values of mini-BESTest in 50-59, 60-69, and +70 years age groups (median range from 23 to 26) were almost similar to those reported by O'Hoski et al. (median range from 20 to 26). These findings indicate the similarity in dynamic balance test of mini-BESTest score regardless of nationality, Iranians or Canadians. However, the normative values of brief-BESTest in those age groups were lower for Iranian compared to Canadians, and differences between the two populations even increased with age. The possible reason might be that the Iranians scored low value in the biomechanical constraints and stability limits sections of the brief- BESTest while those items are removed in mini-BESTest. Differences in the height of the Iranian and Canadian populations could be another reason for differences in values scored on the brief- BESTest as the height can affect the Functional Reach Test (FRT) value scored by subjects [45]. The FRT is used to assess the stability limits of brief-BESTest; Canadians were taller (mean 170 cm) than Iranians (166 cm) in age groups of ≥ 50 years that can explain their better performance in the section brief-BESTest (mean range 2.2-2.7 *vs* 2.0-2.4). These differences between Iranians and Canadians could also be attributable to the low measurement precision at the individual level of the brief-BESTest, in which individual items have a greater weight on the total score. Iranians had lower scores in the transitions–anticipatory postural adjustment section than Canadians. Both tests, mini-BESTest, and brief-BESTest have included the section transitions-anticipatory postural adjustment. However, the transitions-anticipatory postural adjustment section is scored 2 out of the total 28 scores in mini-BESTest compared to 6 scores out of the total 24 scores in brief-BESTest [30], which could contribute to the lower value on the brief-BESTest in Iranians compared to the Canadians.

The IQRs for brief-BESTest total score increased with age among our sample in line with those reported previously for Canadians [30]. Brief-BESTest items are scored on a scale from 0 to 3. Subsequently, more variability and thus higher IQR for total score may be expected when using the brief-BESTest. The highest IQRs were observed for age ≥ 70 on the mini-BESTest and brief-BESTest. The high variation observed in older participants could be due to the differences in the activity level [30] and age-related comorbidities [46]. In this study, participants' activity level and medical status for possible comorbidities were not examined. Another reason might be the ability of the mini-BESTest and brief-BESTest to detect the variations in older adults.

Nevertheless, the increased IQR with age using mini-BESTest and brief- BESTest in older people needs further examination.

Males performed better than females in older age groups. However, younger females performed better than younger males. One possible reason for better balance ability in young females and older males might be their higher level of physical activity. Further investigations with both genders are needed to verify these findings.

We found a decline in all mini-BESTest subscales' scores, except in sensory orientation subscales, in which the median did not decrease across age groups. We found a similar pattern in the brief-BESTest as the sensory orientation subscale scores did not change dramatically across age groups. This finding aligns with O'Hoski et al.'s findings as there was no considerable change in the sensory orientation subscale scores in the brief-BESTest and BESTest, except in the 80-89 years age group, in which there was a clinically significant decline in this subscale's score. Such finding, especially in the case of brief-BESTest, may be due to using a foam with a medium firmness to evaluate this subscale [12]. Studies have shown that foams with lower firmness induce greater postural sway than firm ones, and individuals' performance in standing on foam with open or closed eyes is an interaction between age and foam's firmness [47]. Using a foam with low firmness may enhance the ability of brief-BESTest and mini-BESTest to detect the age-related changes in the sensory orientation subscale, and future studies are needed in this regard.

We found the greatest age-related decline in biomechanical constraints and transitions–anticipatory postural adjustment subscales of brief-BESTest, which is in line with O'Hoski et al.'s findings [30]. Hip strength affects the hip/trunk lateral strength item, which has been used to evaluate biomechanical constraints in the brief-BESTest [12, 26]. Hip muscles strength decreases by age, especially in females [48], which may be a reason for such decline in older participants' performance of biomechanical constraints subscale. Therefore, interventions and rehabilitation programs to increase the hip muscles strength may be beneficial to improve the postural balance in older adults. Such interventions also positively affect the subjects' performance in the one leg stance test, which has been used for the evaluation of transitions–anticipatory postural adjustment subscales [49]. Effects of programs that strengthen the hip muscles on individuals' performance in biomechanical constraints and transitions–anticipatory postural adjustment subscales suggest them as effective interventions as they target two balance systems, which shown greatest declines in older adults.

Limitations

We had several limitations for this study. First, our results may not be applicable to other countries, especially countries that are much different from Iran in terms of lifestyle and health conditions, and there should be more studies in other countries to obtain the exact values of the tests for other countries. Second, we only evaluated the healthy adults, and in the clinical setting, patients, especially older adults, may have comorbidities that may affect their balance, and these findings may not be applicable to these patients. Therefore, there is a need for future studies to evaluate the normative values of mini-BESTest and brief-BESTest in patients with comorbidities. Third, we only evaluated participants' gender, and age as demographic characteristics, and future studies evaluating the association between normative values of these balance tests and other variables such as job may increase the utility of these tests.

Conclusions

In conclusion, this study provided the normative values of mini-BESTest and brief-BESTest for healthy Iranian adults in age decades. The values provided for mini-BESTest and brief-BESTest can be used as reference values when assessing balance in healthy adults and subjects with balance dysfunctions.

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Conflict of interest statement

Authors have no conflict of interest to declare.

Authors' contributions

Conceptualization: SN, ANA; Methodology: SN, ANA; Software: FD, ANA; Validation: ANA; Formal analysis: ANA, FD; Investigation: ANA, NN, PV, MK, MM, FD; Resources: ANA, SN; Writing - Original Draft: ANA; Writing - Review & Editing: All authors; Supervision: SN, NNA; Project administration: ANA, SN; Funding acquisition: ANA, SN.

References

[1] Pollock AS, Durward BR, Rowe PJ, Paul JP. What is balance? Clin Rehabil 2000;14:402-6. https://doi.org/10.1191/0269215500cr342oa.

[2] Johansson R, Magnusson M. Human postural dynamics. Crit Rev Biomed Eng 1991;18:413-37. .

[3] Mancini M, Horak FB. The relevance of clinical balance assessment tools to differentiate balance deficits. Eur J Phys Rehabil Med 2010;46:239-48. .

[4] Adams PF, Martinez ME, Vickerie JL. Summary health statistics for the U.S. population: National Health Interview Survey, 2009. Vital Health Stat 2010;10:1-115.

[5] Verma SK, Willetts JL, Corns HL, Marucci-Wellman HR, Lombardi DA, Courtney TK. Falls and Fall-Related Injuries

among Community-Dwelling Adults in the United States. PLoS One 2016;11:e0150939. https://doi.org/10.1371/journal.pone.0150939.

[6] Stewart BT, Lafta R, Esa Al Shatari SA, Cherewick M, Flaxman A, Hagopian A, Burnham G, Kushner AL. Fall injuries in Baghdad from 2003 to 2014: Results of a randomised household cluster survey. Injury 2016;47:244-9. https://doi.org/10.1016/j.injury.2015.11.006.

[7] Fuller GF. Falls in the elderly. Am Fam Physician 2000;61:2159-68, 2173-4.

[8] Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther 2000;80:896-903.

[9] Schoene D, Wu SM, Mikolaizak AS, Menant JC, Smith ST, Delbaere K, Lord SR. Discriminative ability and predictive validity of the timed up and go test in identifying older people who fall: systematic review and meta-analysis. J Am Geriatr Soc 2013;61:202-8. https://doi.org/10.1111/jgs.12106.

[10] Berg K, Wood-Dauphinee S, Williams JI. The Balance Scale: reliability assessment with elderly residents and patients with an acute stroke. Scand J Rehabil Med 1995;27:27-36.

[11] Blum L, Korner-Bitensky N. Usefulness of the Berg Balance Scale in stroke rehabilitation: a systematic review. Phys Ther. 2008 May;88(5):559-66. https://doi.org/10.2522/ptj.20070205.

[12] Horak FB, Wrisley DM, Frank J. The Balance Evaluation Systems Test (BESTest) to differentiate balance deficits. Phys Ther 2009;89:484-98. https://doi.org/10.2522/ptj.20080071.

[13] O'Hoski S, Sibley KM, Brooks D, Beauchamp MK. Construct validity of the BESTest, mini-BESTest and briefBESTest in adults aged 50 years and older. Gait Posture 2015;42:301-5. https://doi.org/10.1016/j.gaitpost.2015.06.006.

[14] Leddy AL, Crowner BE, Earhart GM. Utility of the Mini-BESTest, BESTest, and BESTest sections for balance assessments in individuals with Parkinson disease. J Neurol Phys Ther 2011;35:90-7. https://doi.org/10.1097/NPT.0b013e31821a620c.

[15] Marques A, Almeida S, Carvalho J, Cruz J, Oliveira A, Jácome C. Reliability, Validity, and Ability to Identify Fall Status of the Balance Evaluation Systems Test, Mini-Balance Evaluation Systems Test, and Brief-Balance Evaluation Systems Test in Older People Living in the Community. Arch Phys Med Rehabil 2016;97:2166-2173.e1. https://doi.org/10.1016/j.apmr.2016.07.011.

[16] Wang-Hsu E, Smith SS. Interrater and Test-Retest Reliability and Minimal Detectable Change of the Balance Evaluation Systems Test (BESTest) and Subsystems With Community-Dwelling Older Adults. J Geriatr Phys Ther 2018;41:173-9. https://doi.org/10.1519/JPT.0000000000000117.

[17] Yingyongyudha A, Saengsirisuwan V, Panichaporn W, Boonsinsukh R. The Mini-Balance Evaluation Systems Test (Mini-BESTest) Demonstrates Higher Accuracy in Identifying Older Adult Participants With History of Falls Than Do the BESTest, Berg Balance Scale, or Timed Up and Go Test. J Geriatr Phys Ther 2016;39:64-70. https://doi.org/10.1519/JPT.0000000000000050.

[18] Franchignoni F, Horak F, Godi M, Nardone A, Giordano A. Using psychometric techniques to improve the Balance Evaluation Systems Test: the mini-BESTest. J Rehabil Med 2010;42:323-31. https://doi.org/10.2340/16501977-0537.

[19] Di Carlo S, Bravini E, Vercelli S, Massazza G, Ferriero G. The Mini-BESTest: a review of psychometric properties. Int J Rehabil Res 2016;39:97-105. https://doi.org/10.1097/MRR.0000000000000153.

[20] Franchignoni F, Godi M, Guglielmetti S, Nardone A, Giordano A. Enhancing the usefulness of the Mini-BESTest for measuring dynamic balance: a Rasch validation study. Eur J Phys Rehabil Med 2015;51:429-37.

[21] Godi M, Franchignoni F, Caligari M, Giordano A, Turcato AM, Nardone A. Comparison of reliability, validity, and responsiveness of the mini-BESTest and Berg Balance Scale in patients with balance disorders. Phys Ther 2013;93:158-67. https://doi.org/10.2522/ptj.20120171.

[22] Tsang CS, Liao LR, Chung RC, Pang MY. Psychometric properties of the Mini-Balance Evaluation Systems Test (Mini-BESTest) in community-dwelling individuals with chronic stroke. Phys Ther 2013;93:1102-15. https://doi.org/10.2522/ptj.20120454.

[23] Bergström M, Lenholm E, Franzén E. Translation and validation of the Swedish version of the mini-BESTest in subjects with Parkinson's disease or stroke: a pilot study. Physiother Theory Pract 2012;28:509-14. https://doi.org/10.3109/09593985.2011.653707.

[24] King LA, Priest KC, Salarian A, Pierce D, Horak FB. Comparing the Mini-BESTest with the Berg Balance Scale to Evaluate Balance Disorders in Parkinson's Disease. Parkinsons Dis 2012;2012:375419. https://doi.org/10.1155/2012/375419.

[25] Hasegawa S, Matsui T, Kishi M, Kouchi H, Watanabe M, Yanagisawa T, Usuda S. Sensitivity to change and responsiveness of the Balance Evaluation Systems Test (BESTest), Mini-BESTest, and Brief-BESTest in patients with subacute cerebral infarction. J Phys Ther Sci 2021;33:69-74. https://doi.org/10.1589/jpts.33.69.

[26] Padgett PK, Jacobs JV, Kasser SL. Is the BESTest at its best? A suggested brief version based on interrater reliability, validity, internal consistency, and theoretical construct. Phys Ther 2012;92:1197-207. https://doi.org/10.2522/ptj.20120056.

[27] Marques A, Silva A, Oliveira A, Cruz J, Machado A, Jácome C. Validity and Relative Ability of 4 Balance Tests to Identify Fall Status of Older Adults With Type 2 Diabetes. J Geriatr Phys Ther 2017;40:227-32. https://doi.org/10.1519/JPT.0000000000000109.

[28] Bravini E, Nardone A, Godi M, Guglielmetti S, Franchignoni F, Giordano A. Does the Brief-BESTest Meet Classical Test Theory and Rasch Analysis Requirements for Balance Assessment in People With Neurological Disorders? Phys Ther 2016;96:1610-1619. https://doi.org/10.2522/ptj.20150550.

[29] Shinohara T, Saida K, Miyata K. Ability of the Brief-Balance Evaluation Systems Test to evaluate balance deficits in community-dwelling older adults: a cross-sectional study. Physiother Theory Pract 2022;38:1381-8. https://doi.org/10.1080/09593985.2020.1840682.

[30] O'Hoski S, Winship B, Herridge L, Agha T, Brooks D, Beauchamp MK, Sibley KM. Increasing the clinical utility of the BESTest, mini-BESTest, and brief-BESTest: normative values in Canadian adults who are healthy and aged 50 years or older. Phys Ther 2014;94:334-42. https://doi.org/10.2522/ptj.20130104.

[31] King L, Horak F. On the mini-BESTest: scoring and the reporting of total scores. Phys Ther 2013;93:571-5. https://doi.org/10.2522/ptj.2013.93.4.571.

[32] Naghdi S, Nakhostin Ansari N, Forogh B, Khalifeloo M, Honarpisheh R, Nakhostin-Ansari A. Reliability and Validity of the Persian Version of the Mini-Balance Evaluation Systems Test in Patients with Stroke. Neurol Ther 2020;9:567-74. https://doi.org/10.1007/s40120-020-00207-2.

[33] Nakhostin-Ansari A, Nakhostin Ansari N, Mellat-Ardakani M, Nematizad M, Naghdi S, Babaki M, Farhangian M, Habibi AH, Tafakhori A, Hasson S. Reliability and validity of Persian versions of Mini-BESTest and Brief-BESTest in persons with Parkinson's disease. Physiother Theory Pract 2022;38:1264-72. https://doi.org/10.1080/09593985.2020.1822967.

[34] Komijani P, Naghdi S, Nakhostin Ansari N, Bolhasani F, Nakhostin Ansari A. Inter- and intra-rater reliability of brief BESTest in balance evaluation of patients with stroke: brief report. Tehran Univ Med J 2018;76:67-73.

[35] Bohannon RW, Larkin PA, Cook AC, Gear J, Singer J. Decrease in timed balance test scores with aging. Phys Ther 1984;64:1067-70. https://doi.org/10.1093/ptj/64.7.1067.

[36] Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. J Geriatr Phys Ther 2007;30:8-15. https://doi.org/10.1519/00139143-200704000-00003.

[37] Steffen TM, Hacker TA, Mollinger L. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Phys Ther 2002;82:128-37. https://doi.org/10.1093/ptj/82.2.128.

[38] Aniansson A, Hedberg M, Henning GB, Grimby G. Muscle morphology, enzymatic activity, and muscle strength in elderly men: a follow-up study. Muscle Nerve 1986;9:585-91. https://doi.org/10.1002/mus.880090702.

[39] Jørgensen MG. Assessment of postural balance in community-dwelling older adults - methodological aspects and effects of biofeedback-based Nintendo Wii training. Dan Med J 2014;61:B4775.

[40] Lord SR, Menz HB. Visual contributions to postural stability in older adults. Gerontology 2000;46:306-10. https://doi.org/10.1159/000022182.

[41] Raz N, Lindenberger U, Rodrigue KM, Kennedy KM, Head D, Williamson A, Dahle C, Gerstorf D, Acker JD. Regional brain changes in aging healthy adults: general trends, individual differences and modifiers. Cereb Cortex 2005;15:1676-89. https://doi.org/10.1093/cercor/bhi044.

[42] Rosenhall U, Rubin W. Degenerative changes in the human vestibular sensory epithelia. Acta Otolaryngol 1975;79:67-80. https://doi.org/10.3109/00016487509124657.

[43] Shaffer SW, Harrison AL. Aging of the somatosensory system: a translational perspective. Phys Ther 2007;87:193-207. https://doi.org/10.2522/ptj.20060083.

[44] Sturnieks DL, St George R, Lord SR. Balance disorders in the elderly. Neurophysiol Clin 2008;38:467-78. https://doi.org/10.1016/j.neucli.2008.09.001.

[45] Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. J Gerontol 1990;45:M192-7. https://doi.org/10.1093/geronj/45.6.m192.

[46] Fortin M, Bravo G, Hudon C, Vanasse A, Lapointe L. Prevalence of multimorbidity among adults seen in family practice. Ann Fam Med 2005;3:223-8. https://doi.org/10.1370/afm.272.

[47] Chaikeeree N, Saengsirisuwan V, Chinsongkram B, Boonsinsukh R. Interaction of age and foam types used in Clinical Test for Sensory Interaction and Balance (CTSIB). Gait Posture 2015;41:313-5. https://doi.org/10.1016/j.gaitpost.2014.09.011.

[48] Cahalan TD, Johnson ME, Liu S, Chao EY. Quantitative measurements of hip strength in different age groups. Clin Orthop Relat Res 1989;(246):136-45.

[49] Wolfson L, Whipple R, Derby C, Judge J, King M, Amerman P, Schmidt J, Smyers D. Balance and strength training in older adults: intervention gains and Tai Chi maintenance. J Am Geriatr Soc 1996;44:498-506. https://doi.org/10.1111/j.1532-5415.1996.tb01433.x.

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History of Medicine and Ethics

A historical and palaeopathological perspective on cancer

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Keywords

Breast cancer • Cancer • Epidemiology • Global health • History of medicine • Palaeopathology • Public health

Summary

Cancer is often wrongly considered to be a modern disease in many popular medical venues. Cancers have been known to humanity since ancient times. In fact, its antiquity can be identified through the application of palaeopathological methodologies. The present perspective demonstrates by means of a historical and palaeopathological analysis how oncological manifestations were present long before the emergence of anatomically modern humans and addresses the epidemiological transition from ancient times to the contemporary world. The final section of the article examines breast cancer and its identification in ancient human remains.

Introduction

According to World Health Organization (WHO) statistics cancer represents "the second leading cause of death globally, accounting for an estimated 9.6 million deaths, or 1 in 6 deaths, in 2018" [1]. Additionally, the WHO identifies oncological manifestations in the lung, prostate gland, colorectal intestine, stomach, and liver as the most common types of cancer in males, whereas the breast, colorectal, lung, neck and thyroid are the most affected anatomical sites in females [1]. According to Siegel et al. "140,000 new cancer cases and 611,720 cancer deaths are projected to occur in the United States" in 2024 [2].

Such figures demonstrate cancer prevalence and the global impact it exerts on global health. For this reason, medicine should not only examine cancer as a modern phenomenon since a much broader perspective on it can be gathered by studying its antiquity and evolutionary trajectory. In addition, by not adopting such an approach, it is also possible to avoid the risk of considering it – the exclusive product of our contemporary societies and lifestyles. A similar interpretative problem could happen with other chronic diseases that are more prevalent today than in the past. The discipline that allows scientists to investigate the antiquity of diseases is called palaeopathology (from Greek: *παλαιός* = ancient, *πάθος* = suffering, disease, *λόγος* = study, research). Palaeopathology utilises both invasive and non-invasive methodologies and techniques also adopted by contemporary medicine (such as histology, radiology, genetics) that offer a complete picture of the clinical presentation of diseases in ancient populations, which are still present in the modern world [3, 4].

Cancer: from mythology to mummy research

With reference to oncologic pathology, the retrospective diagnostic approach has made it possible to show how wrong it was to perceive it as a relatively recent disease and, almost exclusively, linked to contemporary lifestyles and pollution. Before analysing this issue, it is necessary, nevertheless, to recall some linguistic aspects by offering a historical perspective, in order to remedy the superficial and unconscious use of such terms as "neoplasm", "tumour" and "cancer".

Neoplasia (from the Greek *νέος* and *πλάσις*) means a new uncontrolled abnormal growth of tissue; tumour (from the Latin "tumor") originally meant as any kind of tumefaction caused by a tumour process or and inflammatory process, in the first meaning used nowadays interchangeably with "neoplasm"); cancer (in Latin "cancer", in Greek *καρκίνος*, literally meaning "crab") refers to malignant tumours, characterised by high aggressiveness [5].

In Greek mythology the crab *Καρκίνος* (Fig. 1) was sent by goddess Hera to aid the Hydra of Lerna, a monster representing the second labour to which Heracles had been subjected, who was hated by Hera.

Although defeated in the fight, the crustacean was rewarded by the goddess for his loyalty and was made as a constellation, the fourth sign of the Zodiac [5]. This term was already used by the ancient physicians Hippocrates (ca. 460-377 BC), Galen (AD 129-201) and Paul of Aegina (7th century AD), who wondered about the reason for such an identification between the word "crab" and the pathology it indicated. They went so far as to speculate either the similarity between the vascular turgidity in a tumour-affected breast and the crab's legs

Fig. 1. Heracles attacked by the Crab and the Lernaean Hydra. White-ground Attic lekythos, ca. 500-475 BC (Wikipedia Commons- Public domain).

or, metaphorically, the manner in which the disease vigorously and remorselessly grips the body, just as a crab does when it grabs its prey [6].

Hippocrates postulated an early scientific theory on cancer, although previous civilisations may have already developed their own theories on cancer by that time. He assumed that this disease was correlated to an excess of black bile. He believed that cancers, and more broadly any disease, developed when the balance in the four "body humours" (blood, phlegm, yellow bile, and black bile) were in disharmony. For example, the dominance of black bile correlated with the development of cancer.

Afterwards, a Greek physician who trained medicine in Rome, Claudius Galen (AD 129-c. 216) further developed and supported Hippocratic theory, proposing that black bile caused incurable cancer, whereas yellow bile caused curable cancer [7].

Hippocrates further argued and used the word carcinoma, comparing the disease to a crab (καρκίνος) that adheres to its surroundings with its claws [8]. Also, the physician Aulus Cornelius Celsus (25 BC-AD 50), later translated this word and he used the term "cancer", the Latin word for "crab" and Galen described tumours using the Greek term for swelling, "oncos" [9].

Again following WHO statistics, in the current Western world, cardiovascular disease occupies the first position among the causes of death from disease and is followed by cancer, the number of deaths caused by infectious diseases (especially pulmonary) having greatly decreased nowadays, since they are largely controlled through the administration of antibiotics or even preventable by means of vaccination [10], although a resurge in vaccine-preventable infections cannot be ruled out due to the widespread social phenomenon of vaccine hesitancy [11].

Until the end of the 19th century AD, cancer-related deaths occupied the third position in mortality prevalence. The recent surge of various types of cancer can be interpreted in the light of a positive Darwinian selection favouring this nosological category, which is typically associated with the more mature ages of human life [3], together with a higher diagnostic sensitivity due to the advances of medicine and public prevention campaigns. Increasing prevalence of cancer should not, however, be considered as a disease of modernity.

According to science, cancer has been present for hundreds of millions of years and seems to have emerged in multicellular life forms. Even before the dinosaurs, in Dinichthys (a placoderm, an extinct vertebrate like modern fish that lived 340 mln years ago) a cavitation was identified on the inner surface of the jaw, the potential outcome of an oncological process [9]. Another ancient vertebrate, the fossil fish Phanerosteon mirabile (ca. 300 mln years ago) was characterised by the presence of an osteoma, while in the marine reptile Mosasaurus (ca. 75-65 mln years ago) the first case of a tumour, namely an osteoma, in a vertebra was identified [12, 13]. Nonetheless, it is worth mentioning Rotschild's stance on the Mosasaurus osteoma, in that the scientist was convinced that this was not an osteoma but a non-neoplastic hamartoma [14].

How, therefore, can we answer the now long-standing question Did cancer exist in antiquity? The answer can only be an emphatic "yes" according to Faltas [15]. Such a statement is corroborated by an impressive body of evidence from different regions of the world and all time periods [15].

Some of the earliest evidence of cancer is found among fossilised bone tumours in human mummies in ancient Egypt, and references to the same has been found in ancient manuscripts.

Since the earliest civilisations, cancer has indeed been present and recorded: let us take, for instance, the case of Ancient Egypt where the evidence from literary sources (including the Ebers Surgical Papyrus) already indicating the existence of the pathology, has been since the 1970s complemented by a robust body of novel information stemming from the anthropological study of the mortal remains of that ancient population.

According to the anthropologist Eugen Strouhal (1931-2016), one of the founders of the field of palaeopathology, the previous discrepancy between historical data and "field" evidence can be explained through the following points:

- insufficient analysis and description of tumour cases reported in the literature;
- prevalence of the description of cranial tumour lesions related to the preference of old-school anthropologists for the privileged study of the human skull;

- rarity, in past generations of scholars, of palaeopathological training that allows for the detection of tumours on bone;
- necessity to begin the search for tumours as early as the time of archaeological excavation in necropolis [16]. Among the types of cancer found in Ancient Egypt are numerous malignant conditions that are well known by contemporary medical research: osteosarcoma, multiple myeloma, osteolytic metastatic carcinoma, mixed metastatic carcinoma, multiple myeloma, nasopharyngeal carcinoma, primary osteolytic tumours of the maxillary sinus, and ovarian cystadenocarcinoma [16, 17].

In addition, it is relevant to underline how a major limitation is constituted by the fact that many ancient human remains are found skeletonised and only a minimal part of them retains soft tissues at all: even if embalmed or mummified, it does not always happen that they preserve all their soft tissues, yet only part of them.
Among the benign tumoural forms, at the cranial level, it has only recently been possible to demonstrate the actual existence of frontal sinus osteoma in Ancient Egypt, a condition previously only hypothesised on the basis of an unreasoned observation by Strouhal, of a mummy housed in the Musée d'Éthnographie de Neuchâtel (Switzerland) belonging to a male individual who lived between 664 and 332 BC [18]. The same condition was later confirmed in a more recent ancient Egyptian skull [19]. This very pneumatised anatomical district also represents the venue of the recent discovery of another form of osteoma, osteoid osteoma, considered to date not only very rare in that anatomical site but also believed not to have existed in antiquity at all, in the skull of an individual found in the Roman necropolis of Pianotta di Calatabiano (Fiumefreddo, Catania) radiocarbon dated to AD 418-536. In this case, due to the poor state of preservation of the skeletal find, it was opted for a verification of the radiological datum using histology, which demonstrated the typical tissue structure consisting of a central nest surrounded by an area of bony sclerosis [20]. Another interesting case is represented by the evidence of an osteochondroma in distal podal phalanx from the prehistoric hypogeum of Calaforno (Ragusa, Sicily), as demonstrated by a combination of morphological and palaeoradiological methods [21].
Additional evidence of other cancer types, which combined presentations at the skeletal and soft tissue levels, was extensively highlighted in mummified or embalmed bodies by Nerlich and Bianucci [22].
Undoubtedly, the process of carcinogenesis, both in ancient times and in our contemporary society, is intricately interconnected with a combination of diverse elements encompassing environmental, climatic, social, and hereditary influences.
Historically, the most notable risk factors were linked to the inhalation of polycyclic hydrocarbons emitted from the fumes generated by the prevalent practice of smoking food for cooking and preservation purposes. Additionally, the presence of radon gas, a naturally occurring radioactive gas predominantly found in caves and underground areas, further contributed to the potential development of cancer [23].
Moreover, the contamination of crops by toxins produced by plants and microorganisms served as an additional source of risk [23]. Furthermore, the damaging effects of ultraviolet radiation and specific viruses, such as papillomavirus, in conjunction with an individual's genetic predisposition and the consumption of certain medications, all played meaningful roles within the intricate network of factors associated with carcinogenesis [23].

Breast cancer in antiquity: what is the evidence?

Regarding breast pathology, unfortunately, no definitive data on mummies could be found to date due to the poor preservation of mammary tissues in ancient human remains. Speculations about the gynecomastia of Egyptian pharaoh Tutankhamun (ca. 1341-1323 BC), based only on the morphology of artistic depictions and not on the biological data, can be dismissed in the words of Harrison, who was able to study the famous mummy: The distortionate expressionism of Egyptian art in the XVIIIth Dynasty which was introduced by Akhenaten and displayed in his own monuments to the most marked degree, rubbed off on some, but not all, representations of his descendants and the pharaohs Smenkhkare and Tutankhamun [24].
In truth, gynaecomastia has only recently been demonstrated in a mummy through the multidisciplinary study of the body of the Finnish vicar Rungius (ca. AD 1560-1629) [25], while statuary examples from the Hellenistic period have recently been offered [26]. A further example of mammary pathology is the proposed diagnosis of hyaline fibroadenoma in the mummy of Mary of Aragon (AD 1503-1568) [27].
As for breast cancer, on the other hand, suggestive descriptions are found in the Ancient Egyptian Edwin Smith Papyrus (3000-2500 BC), while in Greece Hippocrates and Galen theorised that the aetiology of the disease resided in an excess of black bile, according to the humoral theory of the time [7, 28]. Moreover, in some recent studies based on the iconodiagnostic approach, the presence of breast cancer has been hypothesised in Renaissance works of art, including Michelangelo's masterpiece La Notte in the New Sacristy of the Church of San Lorenzo in Florence [29] and Michele di Rodolfo del Ghirlandaio's work La Notte in Florence [30]. Additionally, Nerlich and colleagues [31], adopting the same approach, reported a possible case of right breast cancer in Rembrandt's work Woman Sitting Half-Dressed beside a Stove (AD 1658).
Despite sporadic remarks from secondary sources, there remains a significant lack of thorough presentation of palaeopathology in biological remains. Nevertheless, the methodical examination of mummies presents an opportunity to address this deficiency in the coming years, offering invaluable knowledge about the well-being and ailments of past civilisations.

Conclusions

To summarise, in order to effectively tackle the complex and ever-evolving challenges faced in oncology and modern medicine as a whole, it is crucial to engage in a thorough and contemplative analysis. This analysis should be enhanced by various branches of medicine, specifically those with an archaeological focus, as they can provide unparalleled insights into the historical context and evolutionary factors that influence diseases. By incorporating these multidisciplinary insights, we can attain a holistic and profound comprehension of the intricate nature of illnesses, ultimately leading to the development of more efficient and effective approaches for prevention, diagnosis, and treatment. Through this comprehensive and collaborative approach, we can strive towards improving the overall well-being and health outcomes for individuals and communities alike.

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Informed consent statement

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Authors' contributions

FMG, VP: designed the study. FMG: conceived the manuscript. FMG, VP, EV, MM: drafted the manuscript. MV, EV, MM: revised the manuscript. MV, VP, EV, FMG, MM: performed a search of the literature. MM, VP: critically revised the manuscript. FMG, EV: conceptualization, and methodology. MV, VP, EV: investigation and data curation. FMG, VP: original draft preparation. EV, MM, FMG: review. MM: editing. All authors have read and approved the latest version of the paper for publication.

References

[1] WHO - Cancer. Available at: https://www.who.int/health-topics/cancer#tab=tab_1 (Accessed on: 19/03/2024).

[2] Siegel RL, Giaquinto AN, Jemal A. Cancer statistics, 2024. CA Cancer J Clin 2024;74:12-49. https://doi.org/10.3322/caac.21820.

[3] Rühli FJ, Galassi FM, Haeusler M. Palaeopathology: Current challenges and medical impact. Clin Anat 2016;29:816-22. https://doi.org/10.1002/ca.22709.

[4] Grauer AL. A century of paleopathology. Am J Phys Anthropol 2018;165:904-914. https://doi.org/10.1002/ajpa.23366.

[5] Andrews T. Dictionary of Nature Myths: Legends of the Earth, Sea, and Sky. Oxford: Oxford University Press 2000, p. 30.

[6] Wagener DJTh. The History of Oncology. Houten: Springer 2009, p. 14.

[7] Di Lonardo A, Nasi S, Pulciani S. Cancer: we should not forget the past. J Cancer 2015;6:29-39. https://doi.org/10.7150/jca.10336.

[8] Hajdu SI. A note from history: landmarks in history of cancer, Part 1. Cancer 2011;117:1097-102. https://doi.org/10.1002/cncr.25553.

[9] Mitrus I, Bryndza E, Sochanik A, Szala S. Evolving models of tumor origin and progression. Tumour Biol 2012;33:911-7. https://doi.org/10.1007/s13277-012-0389-0.

[10] WHO - The top 10 causes of death. Available at: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death (Accessed on: 19/03/2024).

[11] Orsini D, Bianucci R, Galassi FM, Lippi D, Martini M. Vaccine hesitancy, misinformation in the era of COVID-19: lessons from the past. Ethics Med Public Health 2022;24:100812. https://doi.org/10.1016/j.jemep.2022.100812.

[12] Capasso LL. Antiquity of cancer. Int J Cancer 2005;113:2-13. https://doi.org/10.1002/ijc.20610.

[13] Moodie RL. Paleontological evidences of the antiquity of disease. Sci Mon 1918;9:265-281.

[14] Rothschild BM, Schultze H-P, Pellegrini R. Herpetological Osteopathology: Annotated Bibliography of Amphibians and Reptiles. New York: Springer 2012.

[15] Faltas B. Cancer is an ancient disease: the case for better palaeoepidemiological and molecular studies. Nat Rev Cancer 2011;11:76; author reply 76. https://doi.org/10.1038/nrc2914-c1.

[16] Strouhal E. Tumors in the remains of ancient Egyptians. Am J Phys Anthropol 1976;45:613-20. https://doi.org/10.1002/ajpa.1330450328.

[17] Giuffra V, Ciranni R, Fornaciari G. I tumori maligni nell'Antico Egitto e in Nubia. Egitto e Vicino Oriente 2004;27:81-93.

[18] Seiler R, Öhrström LM, Eppenberger P, Gascho D, Rühli FJ, Galassi FM. The earliest known case of frontal sinus osteoma in man. Clin Anat 2019;32:105-9. https://doi.org/10.1002/ca.23301.

[19] Galassi FM, Varotto E, Angelici D, Picchi D. Further Paleoradiological Evidence of Frontal Sinus Osteoma in Ancient Egypt. J Craniofac Surg 2020;31:604-5. https://doi.org/10.1097/SCS.0000000000006240.

[20] Varotto E, Magro MT, Brancato R, Lubritto C, Memeo L, Galassi FM. Unique Osteoid Osteoma of the Frontal Sinus from the Late Roman Empire. J Craniofac Surg 2019;30:965-6. https://doi.org/10.1097/SCS.0000000000005312.

[21] Varotto E, Militello PM, Platania E, Sferrazza P, Galassi FM. Paleopathological study of a podal osteochondroma from the prehistoric Hypogeum of Calaforno (Sicily). Clin Anat 2021;34:19-23. https://doi.org/10.1002/ca.23603.

[22] Nerlich AG, Bianucci R. Paleo-Oncology and Mummies. In: Shin DH, Bianucci R, eds. The Handbook of Mummy Studies. New Frontiers in Scientific and Cultural Perspectives. Singapore: Springer 2021, pp. 131-46.

[23] Fornaciari G, Giuffra V. Lezioni di Paleopatologia. Genova: ECIG 2009, pp. 302-5.

[24] Harrison RG. Tutankhamun postmortem. Lancet 1973;1:259.

[25] Väre T, Galassi FM, Niinimäki J, Junno JA. Potential case of gynecomastia in mummified remains of an early modern period Northern Finnish Vicar. Clin Anat 2018;31(5):641-644. https://doi.org/10.1002/ca.23187.

[26] Galassi FM, Cossarizza A, Varotto E. Superior vena cava syndrome and gynecomastia in antiquity: paleodermatologic considerations on aging in the past. Clin Dermatol 2023;41:309-11. https://doi.org/10.1016/j.clindermatol.2023.05.001.

[27] Ventura L, Gaeta R, Giuffra V, Mercurio C, Pistoia ML, Ciccozzi A, Castagna M, Fornaciari G. Breast pathology in ancient human remains. An approach to mummified mammary gland by modern investigation methods. Pathologica 2014;106:216-8.

[28] Retief FP, Cilliers L. Breast cancer in antiquity. S Afr Med J 2011;101:513-5.

[29] Stark JJ, Nelson JK. The breasts of "Night": Michelangelo as oncologist. N Engl J Med 2000;343:1577-8. https://doi.org/10.1056/NEJM200011233432118.

[30] Bianucci R, Perciaccante A, Charlier P, Appenzeller O, Lippi D. Earliest evidence of malignant breast cancer in Renaissance paintings. Lancet Oncol 2018;19:166-7. https://doi.org/10.1016/S1470-2045(18)30035-4.

[31] Nerlich AG, DeWaal JC, Donell ST, Bianucci R. Breast cancer in Woman Sitting Half-Dressed beside a stove (1658) by Rembrandt van Rijn. Breast 2022;64:134-5. https://doi.org/10.1016/j.breast.2022.06.001.

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History of Medicine and Ethics

Balto and Togo during the cold winter of Alaska (1925): the two canine heroes in the fight against diphtheria

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Keywords

Diphtheria • Immunization • Antitoxin • Dogs • History of vaccines and vaccinations

Summary

In recent years, diphtheria has re-emerged in areas with inadequate vaccination coverage, and Europe has not been spared with several cases among migrants. Diphtheria is a potentially fatal infection caused mainly by toxigenic strains of Corynebacterium diphtheriae. Due to the high mortality rate, especially among young children, the fight against diphtheria is considered one of the first conquests of immunization. In the history of medicine, there is a unique case of an unconventional response to a diphtheria outbreak in which sled dogs were used to overcome the supply difficulties of diphtheria antitoxin. The mass media followed the medical response to the outbreak and raised audience awareness of public health issues. The facts of Nome, Alaska, in 1925 can serve as a catalyst to rethink conventional responses to diphtheria outbreaks in low-income countries today and promote mass media awareness of public health importance.

Notes on the history of active and passive immunization

Ever since the advent of written evidence, it had always been suspected that a person who had recovered from a certain disease became immune to contracting it again. Indeed, some 2,500 years ago, Thucydides (460 BC-404 or 399 BC; Fig. 1), in his description of an epidemic that struck Athens, observed that "No one has ever been affected a second time, or at least fatally" [1].

As early as the Middle Ages, this conviction prompted attempts to elicit immunity to smallpox by inoculating materials taken from the skin of affected patients into healthy subjects, a procedure that was very risky. However, towards the end of the 18th century, an English doctor named Edward Jenner introduced a procedure that was similar, but much safer (Fig. 2). In 1798, he published an investigation into the causes and effects of "Variolae vaccinae", a disease known as "cowpox", which had been discovered in some counties of England. Jenner described 23 cases of subjects whom he first vaccinated with material taken from patients with cowpox and subsequently contaminated with smallpox and observed that these subjects did not contract smallpox (Fig. 2).

Immunity is the body's ability to resist or fight a particular infection or toxin, *i.e.* to defend itself against diseases caused by certain bacteria or viruses; it may occur naturally (following exposure to bacteria or viruses), or it may be elicited through vaccination. Those who are vaccinated against a given disease do not usually contract that disease or else contract it only in a mild form.

As immunization consists of the acquisition of a state of immunity against a specific antigen, it helps the organism to defend itself against diseases caused by certain bacteria or viruses, enabling the subject to resist attack by microorganisms that would otherwise cause an infectious disease (this usually occurs through inoculation) [2]. When immunization results from the administration of a vaccine, it is known as active immunization. By contrast, when the process is activated through immunoglobulins, we have passive immunization.

In the history of public health and the prevention of serious diseases, vaccines have proved very effective, improving people's health worldwide [3]. In countries where vaccines are widely used, many diseases that were once frequent and lethal (*e.g.* polio and diphtheria) [4] have now become rarer or have been brought under control [5]. Indeed, in the case of smallpox, vaccination has enabled the disease to be eradicated.

Background and aims of the study

In recent years, diphtheria has reappeared in areas with poor vaccination coverage. Renewed interest has been raised after the outbreak in the Rohingya migrant camp in Bangladesh in 2017 [6]. In addition, outbreaks have been recorded on the African continent in the last two years. Specifically, at least 13416 suspected cases and

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Fig. 1. Tucidide (Θουκυδίδης, Thūkydídēs) (Alimunte, 460 a.C. - Atene, after 404 a.C., o 399 a.C.) (Adapted by the authors. Public domain – wikipedia commons).

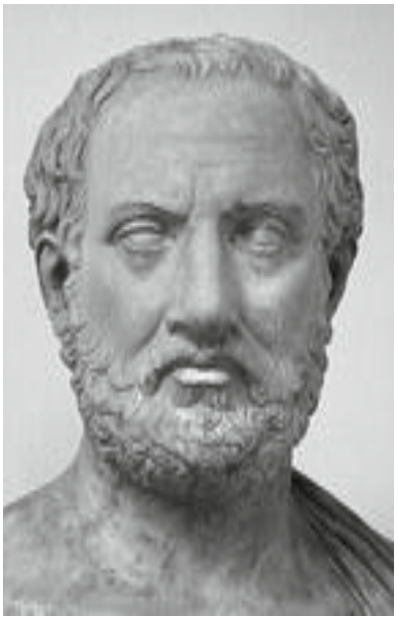
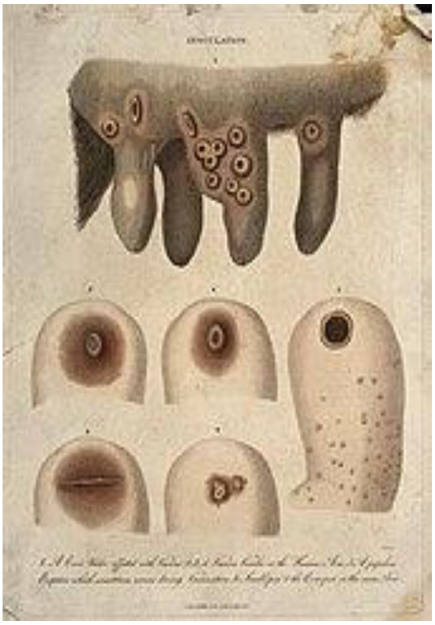


Fig. 2. Jenner's discovery of the link between cowpox pus and smallpox in humans helped him to create the smallpox vaccine. (Adapted by the authors. Public domain - wikipedia commons).



8576 confirmed cases of diphtheria have been registered in Nigeria since May 9, 2022. People with confirmed diphtheria were unvaccinated or partially vaccinated in 63-9% of cases. The main reason for this epidemic is an historical gap in immunization coverage [7]. Europe has not remained untouched. Indeed, between 2022 and 2023 an increase of reported diphtheria cases among migrants in Europe has been recorded. Such disease was correlated to a high volume of asylum seekers arriving by small boats to England and among migrants in Germany during 2022 [8, 9].

The aim of this work is to provide a comprehensive narrative review about the diphtheria epidemic of Nome, Alaska, in 1925. It will provide a new perspective on the success of an unconventional approach to public health emergencies in the history of medicine and may stimulate reflection on the responses to diphtheria outbreaks faced by low-income countries today. Scientific databases (*e.g.* PubMed and Google Scholar) and historical records have been reviewed.

Dogs in medicine

Throughout history, dogs have played significant roles in medical practice, providing emotional support, therapy, and even contributing to disease diagnosis and treatment. The evolution of their involvement in medicine reflects the deep connection between humans and animals, as well as the recognition of their extraordinary sense of smell and emotional sensitivity [10].

In medicine, dogs have been called "medical dogs", serving various roles. They have been used to assist people with visual impairments, to detect diseases such as cancer and epilepsy, to improve human mental and physical health [11, 12].

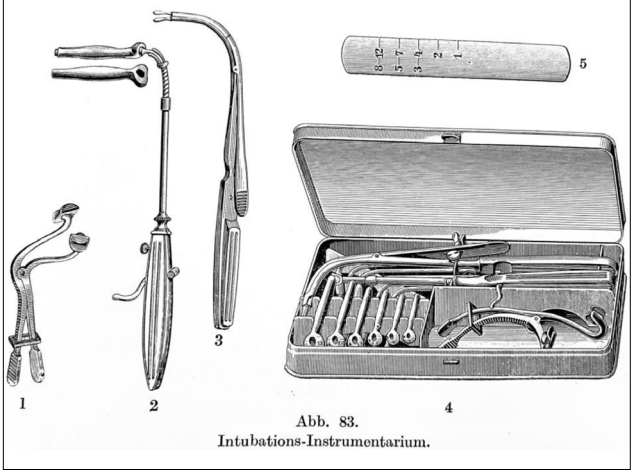
In addition, some dogs are trained to alert their owners in case of imminent emergencies and play an important role in search and rescue, helping to locate people who are lost or buried under rubble following natural disasters or accidents [13, 10]. In summary, dogs' involvement in medicine reflects their versatility, intelligence, and ability to form deep bonds with humans. As further discussed, their presence brought tangible benefits also in the history of preventive medicine.

Notes on diphtheria and the history of its antitoxin

Diphtheria is a potentially fatal infection caused mostly by toxigenic strains of *Corynebacterium diphtheriae*. The disease is usually an acute respiratory infection characterized by the formation of a pseudomembrane in the throat [14]. It spreads easily as the basic reproductive number is 1.7-4.3 [15]. The progression of the respiratory form typically involves prodromal symptoms leading to membranous inflammation of the pharynx, tonsils, or larynx within 2 days. If left untreated, death may occur within 1-2 weeks due to asphyxia resulting from airway obstruction. Toxic cardiomyopathy emerges 1-2 weeks after the onset of respiratory symptoms in 10-25% of patients and contributes to 20-25% of deaths in untreated cases [15, 16].

Diphtheria can be fatal today, as it was at the beginning of the 20th century. The case-fatality ratio for untreated, non-vaccinates cases has been estimated at 29%, and it is estimated to be still 5-10% if treated. Notably, children

Fig. 3. Image representing the instruments used in the early 20th century for intubation. Taken from the chapter on diphtheria of Handbuch der inneren Medizin. Infektionskrankheiten (1911). Imaged revisited by the authors from an hardcover copy of the manual.



under 5 years old face a higher likelihood of death due to symptomatic infection compared to adults over 20 years old, with a relative risk [RR] of 1.5 [95% CrI, 1.4-1.6], due to smaller airways [15, 17, 18].

As can be seen from the manuals of the time, diphtheria was one of the main indications for endotracheal intubation due to airway complications (Fig. 3) [19]. Moreover, systemic manifestations such as myocarditis and neuropathy may also occur. These are due to the diphtheria toxin, an exotoxin produced by the pathogen that inhibits protein synthesis and causes cell death. Skin infections are also possible [14]. Diphtheria toxin is the major known virulence factor of *C. diphtheriae*; the structural gene encoding diphtheria toxin (tox) is carried in the genome of a family of corynebacteriophages. The most virulent strains may carry two or three copies of tox inserted into the genome. Even though tox is of bacteriophage origin, the regulation of toxin production is under bacterial control [14].

C. diphtheriae, a gram-positive bacterium, was one of the first bacterial pathogens to be isolated and cultivated in pure culture. The diphtheria exotoxin is also one of the first toxins to be discovered [20].

As a matter of fact, Edwin Klebs (1834-1913) proved that *C. diphtheriae* was the causative agent of diphtheria in 1883. One year later, Friedrich August Johannes Loeffler (1852-1915) postulated that the damage to the internal organs was caused by a soluble toxin. By 1888, Émile Roux (1853-1933) and Alexandre Yersin (1863-1943) demonstrated that a potent exotoxin was the most important virulence factor for the disease [21].

The control of diphtheria, which was one of the most feared childhood infectious diseases, is considered the first conquest of immunization [22]. Diphtheria antitoxin (DAT) was developed after the demonstration that the blood of diphtheria-immunized animals (mainly horses) was effective in treating sick patients. After the introduction of antitoxin in 1894, the decline in the mortality rate accelerated to an average of over 10 percent per year, and a similar decline was observed after the introduction of vaccination at the end of 1918 in the United States [23]. Interestingly, a recent systematic review found that DAT can reduce mortality by 76%. Thus, antibiotics must be paired with diphtheria antitoxin to limit morbidity also in actual management of the disease [15].

In the late decades of the 19th century, knowledge of hygienic measures, such as isolation, for diphtheria cases was poor. It was common practice to keep the patient in quarantine for 30 days after the onset of symptoms. A 30-day isolation was also required for the re-admission of children to school. Nevertheless, the topic was hardly discussed, as stated in an original paper from Bristol, Great Britain, 1898 [24].

The facts of Nome, Alaska, 1925

The frontier town of Nome in Alaska was settled after the discovery of a gold mine in 1898. The village, located near the Arctic Circle and the Yukon River, was not served by the railroad, and was isolated from the state's major cities during the long winters. In fact, there was no train from Nenana (the local main city) to Nome and horses were unsuitable due to the cold. In addition, traveling by bicycle was too risky, as evidenced by some original diaries of that time [25].

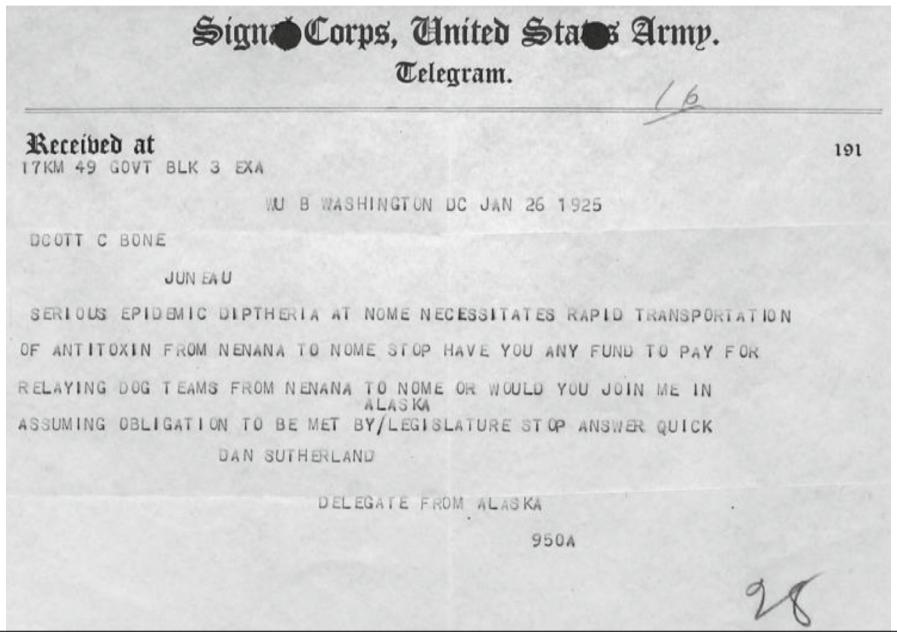
In January 1925, some children of the local Eskimo population began to show symptoms that Curtis Welch, the local doctor, soon recognized as diphtheria. Specifically, he noted a fatal case of tonsillitis and soon thereafter other upper respiratory illnesses in children with pathognomonic membranes. Unfortunately, the only DAT available, manufactured by Lilly's, had expired years earlier. Nevertheless, Welsh decided to use a few thousand units of it [26].

He immediately recognized the need for more DAT, as the Inuit, the indigenous people of Alaska, had little or no immunity to the disease. The first patient was diagnosed on January 11. He immediately notified the fact to Mayor George Maynard and a temporary board of health was set up. Welch continued to make recommendations, which the board implemented, such as closing all public buildings, restricting all public gatherings, restricting the movement of children on all roads, and restricting the movement of adults to official business [26]. From the correspondence of Governor Scott C. Bone (Governor of the Alaska Territory from 1921 to 1925), it is known that expedited transportation of DAT from Nenana to Nome was required beginning January 26, 1925 (Fig. 4).

The H.K. Mulford Co., Philadelphia, had the legal license for the production of medical products such as diphtheria antitoxin. The company was asked to manufacture and ship DAT for the urgent demand in Alaska [27].

In the region of Nome temperatures frequently dropped below -40 °C [28]. Prolonged exposure to these temperatures may result in hypothermia, defined as a body temperature of 35 °C or less. When body

Fig. 4. Bone's correspondence files on the 1925 Serum Run to Nome. Alaska. Office of the District and Territorial Governor. Courtesy provided by Alaska State Library Historical Collections.



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DAN SUTHERLAND

DELEGATE FROM ALASKA

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temperature falls below 32°C, depression of the central nervous system and altered mental status are reported [29]. In case of trauma, mortality increases also because a low body temperature interferes with clotting, impairing platelet adhesion and enzymatic coagulative function, worsening ongoing bleeding [30]. Moreover, prolonged exposure to subfreezing temperatures, can cause tissue ischemia and necrosis through an immediate

Fig. 5. Celebrated sled dog Balto with Gunnar Kaasen, the Norwegian immigrant musher that finally and successfully delivered diphtheria antitoxin to Nome, Alaska in 1925 (Pictures of Public domain - wikipedia commons).

Fig. 6. Leonhard Seppala posing with six of his sled dogs, the first from left to right is the heroic Togo (Pictures of Public domain - wikipedia commons).

cold-induced cell death or after the reperfusion-related inflammatory process [30, 31]. These injuries include the loss of fingers or part of the limbs [32, 33].
The transportation of DAT from Nenana – where the last train station was available – under such extreme environmental conditions required an unconventional method. At such an extreme point in the history of medicine and humanity, dogs were asked to help humans where advances in technology felt short. Indeed, Governor Bone made the decision to deploy a relay of several sled dog teams for the cross-country run. The dog sled trek was not scheduled to begin until January 27, when the train full of DAT units arrived in Nenana. In the end twenty riders and dog teams took part in the voyage. The two most notable teams (Figs. 5, 6) were: Leonhard Seppala (1877-1967) with his lead dog Togo, a Siberian Husky (1913-1929), and Gunnar Kaasen (1882-1960) with his famous lead dog Balto (1919-1933). From January 27 to February 2, the teams covered 674 miles (1085 kilometers) bringing DAT units from Nenana to Nome [27].

Balto in medical mass media and science

Since the success of the DAT run in 1925, commemorative events and memorials have been organized in its honor. The famous statues of Balto and Togo, which can be seen every day in Manhattan's Central Park and Seward Park, show the importance of this collaboration between humans and non-humans in the history of science. In addition, at least 5 films commemorate the history of these sled dogs [34].
Both science and fiction love this unique experience. In fact, in 2023, Moon KL and colleagues published an article in the journal Science entitled: "Comparative genomics of Balto, a famous historic dog, captures lost diversity of 1920s sled dogs" [35]. Thanks to this unconventional approach to preventive medicine, the diphtheria vaccination and the DAT have been known worldwide since 1925.

Conclusions

The history of vaccinology has been considered as the chronicle of medical contributions of vaccinologists and public health practitioners coupled with unconventional methods such as human-animal cooperation [27]. The steady supply of diphtheria treatment, including diphtheria antitoxin, to achieve the best clinical outcomes of high-risk patients was a priority in 1925 as it is in 2024; as recently emphasized [7]. As well described in the recent diphtheria epidemic in Nigeria, the main causes of the outbreak were low vaccination coverage, inadequate availability of drugs, an inefficient cold chain system and cultural barriers combined with environmental factors [36]. Interestingly, in 1925 Alaskans natives believed the disease was caused by an angry supernatural spirit; depicting how cultural beliefs impact health practice acceptance in the present and in the past [37]. It is our opinion that rethinking unconventional approaches to DAT and antibiotics delivery could shape the ongoing diphtheria epidemics in developing countries. Unconventional methods could be hypothesized also to reduce vaccination hesitancy of local populations.
Moreover, as the paper indicates, the facts of Nome were discussed daily by the American public and later left their mark on popular culture. The mass media, then as now, had a major impact on curbing the spread of infectious diseases by raising public awareness and limiting the occurrence of future outbreaks in the years to come [38]. Newspapers and radio that time as modern mass media now follow vaccination campaigns in high-income countries with interest and enthusiasm. Nevertheless, there is a media gap in some parts of the world that are heavily affected by infectious diseases.
We believe that the lessons learned from the 1925 Nome outbreak should both enhance the dissemination of epidemic-related information and promote unconventional approaches to managing and mitigating the ongoing diphtheria epidemics in developing countries. Nevertheless, vaccination must be strengthened worldwide as the most important prevention goal to avoid extreme remedies such as the one of Nome. As a matter of fact, vaccination is able to mitigate epidemic and pandemic respiratory diseases such as influenza; still related to respiratory and cardiovascular mortality also in people under 65 years [39].

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Authors' contributions

OS, MM: designed the study. OS: conceived the manuscript. OS, LC, MM: drafted the manuscript. MC, AP, OS, MM: revised the manuscript. OS, LC, MC, AP: performed a search of the literature. SdB, MC, AP:

critically revised the manuscript; conceptualization, and methodology. OS, MM; investigation and data curation. MC, AP, OS, SdB: original draft preparation. OS: review. All authors have read and approved the latest version of the paper for publication.

References

[1] Tucidide. La guerra del Peloponneso. L. Canfora (a cura di). Einaudi-Gallimard, Torino 1996 [Collana Biblioteca della Pléiade].

[2] Orsini D, Martini M. From inoculation to vaccination: the fight against smallpox in Siena in the 18th and 19th centuries. Infez Med 2020;28:634-41.

[3] Parodi A, Martini M. History of vaccine and immunization: Vaccine-hesitancy discussion in Germany in XIX century. Vaccine 2023;41:1989-93. https://doi.org/10.1016/j.vaccine.2023.02.029.

[4] Martini M, Orsini D. The fight against poliomyelitis through the history: past, present and hopes for the future. Albert Sabin's missing Nobel and his "gift to all the world's children". Vaccine 2022;40:6802-5. https://doi.org/10.1016/j.vaccine.2022.09.088.

[5] Bragazzi NL, Gianfredi V, Villarini M, Rosselli R, Nasr A, Hussein A, Martini M, Behzadifar M. Vaccines Meet Big Data: State-Of-The-Art And Future Prospects. From the Classical 3Is ("Isolate-Inactivate-Inject") Vaccinology 1.0 to Vaccinology 3.0, Vaccinomics, and Beyond: A Historical Overview. Front Public Health. 2018;6:62. https://doi.org/10.3389/fpubh.2018.00062.

[6] Eisenberg N, Panunzi I, Wolz A, Burzio C, Cilliers A, Islam MA, Noor WM, Jalon O, Jannat-Khah D, Gil Cuesta J. Diphtheria Antitoxin Administration, Outcomes, and Safety: Response to a Diphtheria Outbreak in Cox's Bazar, Bangladesh. Clin Infect Dis 2021;73:e1713-8. https://doi.org/10.1093/cid/ciaa1718.

[7] Balakrishnan VS. Diphtheria Outbreak in Nigeria. Lancet Microbe 2024;5:e11. https://doi.org/10.1016/S2666-5247(23)00330-0.

[8] O'Boyle S, Barton HE, D'Aeth JC, Cordery R, Fry NK, Litt D, Southgate R, Verrecchia R, Mannes T, Wang TY, Stewart DE, Olufon O, Dickinson M, Ramsay ME, Amirthalingam G. National public health response to an outbreak of toxigenic Corynebacterium diphtheriae among asylum seekers in England, 2022: a descriptive epidemiological study. Lancet Public Health 2023;8:e766-75. https://doi.org/10.1016/S2468-2667(23)00175-5.

[9] Badenschier F, Berger A, Dangel A, Sprenger A, Hobmaier B, Sievers C, Prins H, Dörre A, Wagner-Wiening C, Külper-Schiek W, Wichmann O, Sing A. Outbreak of imported diphtheria with Corynebacterium diphtheriae among migrants arriving in Germany, 2022. Euro Surveill 2022;27:2200849. https://doi.org/10.2807/1560-7917.ES.2022.27.46.2200849.

[10] Houpt KA. Domestic Animal Behavior for Veterinarians and Animal Scientists. John Wiley & Sons 2018.

[11] Grandgeorge M, Bourreau Y, Catherine N, Tordjman S. La zooterapia nella riabilitazione: una revisione sistematica. La Presse Médicale 2012;41:e477-87.

[12] Herzog H. The impact of Pets on Human Health and psychological Well-Being. Curr Dir Psychol Sci 2011;20:236-9. https://doi.org/10.1177/0963721411415220.

[13] Marino L, Scott O. Lilienfeld. Dolphin-Assisted Therapy: More Flawed Data and More Flawed Conclusions. Anthrozoös 2007;20:239-49. https://doi.org/10.2752/089279307X224782.

[14] Sharma NC, Efstratiou A, Mokrousov I, Mutreja A, Das B, Ramamurthy T. Diphtheria. Nat Rev Dis Primers 2019;5:81. https://doi.org/10.1038/s41572-019-0131-y.

[15] Truelove SA, Keegan LT, Moss WJ, Chaisson LH, Macher E, Azman AS, Lessler J. Clinical and Epidemiological Aspects of Diphtheria: A Systematic Review and Pooled Analysis. Clin Infect Dis 2020;71:89-97. https://doi.org/10.1093/cid/ciz808.

[16] Dash N, Verma S, Jayashree M, Kumar R, Vaidya PC, Singh M. Clinico-epidemiological profile and predictors of outcome in children with diphtheria: a study from northern India. Trop Doct 2019;49:96-101. https://doi.org/10.1177/0049475518823657.

[17] Muscat M, Gebrie B, Efstratiou A, Datta SS, Daniels D. Diphtheria in the WHO European Region, 2010 to 2019. Euro Surveill 2022;27:2100058. https://doi.org/10.2807/1560-7917.ES.2022.27.8.2100058.

[18] Exavier MM, Paul Hanna M, Muscadin E, Freishstat RJ, Brisma JP, Canarie MF. Diphtheria in Children in Northern Haiti. J Trop Pediatr 2019;65:183-7. https://doi.org/10.1093/tropej/fmy021.

[19] Handbuch der inneren Medizin v. 1, 1911. J. Springer, 1911.

[20] Collier R.J. Understanding the Mode of Action of Diphtheria Toxin: A Perspective on Progress during the 20th Century. Toxicon 2001;39:1793-803. https://doi.org/10.1016/S0041-0101(01)00165-9.

[21] Murphy JVPE, Banwell AHR, McGrouther DA. J Trauma. 2000;48:171-8. https://doi.org/10.1097/00005373-200001000-00036.

[22] Rappuoli R, Malito E. History of Diphtheria Vaccine Development. In: Burkovski A, eds. Corynebacterium diphtheriae and Related Toxigenic Species. Springer, Dordrecht 2014, pp. 225-38.

[23] Kleinman LC. To End an Epidemic. Lessons from the History of Diphtheria. N Engl J Med 1992;326:773-7. https://doi.org/10.1056/NEJM199203123261118.

[24] Bertram MHR. Isolation after Diphtheria Bristol Med Chir J (1883) 1898;16:101-8.

[25] Rosen J. La magia delle due ruote. Storie e segreti della bicicletta in giro per il mondo. Bollati Boringhieri 2023.

[26] Welch C. The Diphtheria Epidemic at Nome. JAMA 1925;84:1290-1. https://doi.org/10.1001/jama.1925.02660430048031.

[27] Aboul-Enein BH, Puddy WC, Bowser JE. The 1925 Diphtheria Antitoxin Run to Nome - Alaska: A Public Health Illustration of Human-Animal Collaboration. J Med Humanit 2019;40:287-96. https://doi.org/10.1007/s10912-016-9428-y.

[28] Salisbury G, Laney S. The Cruellest Miles: The Heroic Story of Dogs and Men in a Race Against an Epidemic. Bloomsbury Publishing PLC. 2023.

[29] Durrer B, Brugger H, Syme D; International Commission for Mountain Emergency Medicine. The medical on-site treatment of hypothermia: ICAR-MEDCOM recommendation. High Alt Med Biol 2003;4:99-103. https://doi.org/10.1089/152702903321489031.

[30] Wolberg AS, Meng ZH, Monroe DM 3rd, Hoffman M. A systematic evaluation of the effect of temperature on coagulation enzyme activity and platelet function. J Trauma 2004;56:1221-8. https://doi.org/10.1097/01.ta.0000064328.97941.fc.

[31] Murphy JV, Banwell PE, Roberts AH, McGrouther DA. Frostbite: pathogenesis and treatment. J Trauma 2000;48:171-8. https://doi.org/10.1097/00005373-200001000-00036.

[32] Pandolf KB, Burr RE. Medical Aspects of Harsh Environments. Department of the Army 2001.

[33] Carceller A, Javierre C, Ríos M, Viscor G. Amputation Risk Factors in Severely Frostbitten Patients. Int J Environ Res Public Health 2019;16:1351. https://doi.org/10.3390/ijerph16081351.

[34] "Find." n.d. IMDb. Available at: https://www.imdb.com/find/?q=balto&ref_=nv_sr_sm (Accessed on: March 3, 2024).

[35] Moon KL, Huson HJ, Morrill K, Wang MS, Li X, Srikanth K; Zoonomia Consortium; Lindblad-Toh K, Svenson GJ, Karlsson EK, Shapiro B. Comparative genomics of Balto, a famous historic dog, captures lost diversity of 1920s sled dogs. Science 2023;380:eabn5887. https://doi.org/10.1126/science.abn5887.

[36] Abdulrasheed N, Lawal L, Mogaji AB, Abdulkareem AO, Shuaib AK, Adeoti SG, Amosu OP, Muhammad-Olodo AO, Lawal

AO, Jaji TA, Abdul-Rahman T. Recurrent diphtheria outbreaks in Nigeria: A review of the underlying factors and remedies. Immun Inflamm Dis 2023;11:e1096. https://doi.org/10.1002/iid3.1096.

[37] Schilp JL. Dogs in Health Care Pioneering Animal-Human Partnerships. Jefferson: McFarland & Company, Incorporated Publishers 2019.

[38] Quantifying the Potential Impact of Mass Media Campaigns on Mitigating the Spread of Chikungunya Virus during Outbreaks in Heterogeneous Population. Informatics in Medicine Unlocked 2023;40:101296.

[39] Gasparini R, Bonanni P, Amicizia D, Bella A, Donatelli I, Cristina ML, Panatto D, Lai PL. Influenza epidemiology in Italy two years after the 2009-2010 pandemic: need to improve vaccination coverage. Hum Vaccin Immunother 2013;9:561-7.

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History of Medicine and Ethics

The history of polio vaccination with "Sabin's OPV" 60 years after its introduction in Italy: an unforgivable "delay"

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History of vaccines and vaccinations • Polio • Sabin's OPV • Public health • Hygiene

Summary

In the spring of 1964, polio vaccination with the oral vaccine developed by Albert Sabin began in Italy. Polio was feared in the world and in Italy. Thus, between 1957 and the beginning of 1958, Italian children began receiving the "Salk vaccine", though the results were not particularly convincing. In July 1960, the international scientific community was able to verify the data from the mass testing of the Sabin vaccine. It became clear that the OPV, could prevent the virus from multiplying, thereby providing greater protection and determining the eradication of the disease. In 1960 over 70 million people in the USSR alone had already received the oral vaccine and mass vaccination in the USA would start in March 1961. However, in Italy there was no similar initiative; only later the new vaccine was accepted but was not made compulsory at the beginning. As a result of the commission's report, registration of the "Polioral" vaccine, was authorized in September 1962 but the sale of the vaccine was not authorized until November 1963. At the beginning of 1964, the production of "Polioral" started and the product was marketed and on the 1 st of March 1964, anti-polio vaccination with the "Sabin anti-polio vaccine" also began in Italy.

This manuscript focuses on a crucial issue about a historical delay for public health and it points out as the preparation and diffusion of the Sabin polio vaccine demonstrates that decisions regarding health treatments, and specifically vaccination campaigns, must be based exclusively on the results of clinical studies and on independent evaluation by the scientific community. This process ensures trust in vaccines, adequate protection of public health andcitizens' well-being.

Background

In the spring of 1964, polio vaccination with the oral vaccine developed by Albert Sabin began in
Italy. Sabin's name became known to Italians on the occasion of the 3rd International Polio Conference, which was held in Rome in September 1954. At the Conference, two speakers aroused keen public interest: the American bacteriologist, Jonas Edward Salk (1914-1995), professor of virology at the University of Pittsburgh, who presented his Studies on non-infectious vaccines in poliomyelitis, and a Polish naturalized American professor, Albert Bruce Sabin (1906-1993), director of the Children's Hospital Research Foundation of the University of Cincinnati, who discussed non-virulent viruses for immunization against poliomyelitis [1, 2] (Fig. 1).

In the same year, John Franklin Enders, Thomas Huckle Weller and Frederick Chapman Robbins were awarded the Nobel Prize for Physiology and Medicine "For their discovery of the ability of poliomyelitis viruses to grow in cultures of various types of tissue" [3]. Indeed, at the end of the 1940s, the research group directed by Enders succeeded in cultivating the polio virus in large quantities

Fig. 1. Albert Sabin examining a control preparation of his vaccine at the Sclavo Institute (Photo: University Museum System of Siena - SIMUS).

in the laboratory, thereby laying the foundations for the development of future vaccines. Over the next few years, several researchers carried out various studies aimed at producing a vaccine against polio. An apparently rare clinical condition that occurred only sporadically before the end of the 19th century, the disease spread globally after the beginning of the 20th century. "At its height, from 1950-1954, poliomyelitis resulted in the paralysis of some 22,000 U.S. citizens each year, equivalent to an average annual rate of 14.6 per 100,000. Many thousands were left permanently disabled by the disease, while many others suffocated as a consequence of respiratory paralysis" [4].

The American writer Philip Roth (1933-2018), in his novel Nemesis, described the public anxiety at the time: "People are up in arms. People are terrified. Everybody is frightened for their children" [5].

Given the growing number of cases and the public's rampant fear, virologists claimed that a vaccine was the only hope. Building on the results obtained by Enders, Jonas Salk developed his Inactive Vaccine (IPV) against polio at the beginning of the 1950s. Based on a virus that had been killed with formaldehyde, this vaccine was injected intramuscularly and favored the appearance of antibodies, thereby eliciting immunity to the disease. In 1952, Salk had already administered his vaccine to 43 children. Meanwhile, in 1953, the United States suffered its largest polio epidemic, with 58,000 cases and 3,100 deaths. Despite fears and doubts regarding the vaccine, awareness that it was needed was steadily growing.

On April 26, 1954, the first large blind clinical trial ever performed began, which involved nearly 2 million children. It took a year to complete the analysis of the results, and on April 12, 1955, Salk's inactivated vaccine (IPV) was declared to be effective. The fight against polio had apparently been won [6].

In the last days of April 1955, however, just two weeks after distribution of the vaccine had started, a serious accident occurred. Two batches of the vaccine produced in the laboratories of "Cutter" (a Berkeley pharmaceutical company) contained residues of live poliovirus: 192 cases of paralytic polio occurred among vaccinated children and their family members, and 11 people died [7].

The incident prompted the government to suspend the vaccination program and to revise federal requirements for vaccine production. Above all, it generated profound public mistrust of vaccines and led to the suspension of studies on the development of new vaccines [8, 9].

Meanwhile, at the University of Cincinnati, Albert Sabin was also working on a vaccine. However, he adopted a completely different approach; he prepared a vaccine from a live attenuated virus obtained through various passages of the virus in culture so that it lost its pathogenicity. This was the beginning of the Oral Polio Vaccine (OPV).

Commercial interests in the United States, however, led to a sort of boycott of the OPV, and Sabin was forced to carry out his large-scale testing in the Soviet Union. From 1959 to 1961, millions of children were vaccinated with his vaccine, 77 million in the USSR alone. These first vaccinations yielded gratifying results. Nevertheless, despite these good results, the National Foundation for Infantile Paralysis preferred to continue its prevention campaigns with Salk's preparation, which had been perfected [10]. Only in 1960, thanks to an important endorsement by the WHO, there was a trial of the "Sabin vaccine" undertaken in the United States. This ushered in a new era of the polio vaccine, and the USA definitively replaced Salk's vaccine with Sabin's. Sabin's vaccine was cheap to produce and very easy to administer on a sugar lump to children. The method of administration of the Sabin vaccine inspired the popular song, written by the Sherman brothers, in the film "Mary Poppins", the refrain of which states: "Just a spoonful of sugar helps the medicine go down in a most delightful way" [11].

Poliomyelitis in Italy: a tragic delay in the acceptance of Sabin's vaccine

Polio was also feared in Italy, where between 4,000 and 8,000 cases occurred every year. Thus, between 1957 and the beginning of 1958, Italian children began receiving the "Salk vaccine", however the results were not particularly convincing. In the same period, during the International Conference on Polio held in Copenhagen in July 1960, the international scientific community was able to verify the data from the mass testing of the Sabin vaccine. It became clear that the OPV, which acted directly at the intestinal level, where the first infection occurs, could prevent the virus from multiplying, thereby providing greater protection and determining the eradication of the disease. Almost a year earlier, on the 4th of September 1959, Sabin himself had held a conference in Milan entitled "Present status of field trials with an oral, live attenuated Poliovirus Vaccine", during which he had explicitly stated: "In none of the preliminary studies, involving several thousand children and adults, was there any evidence that multiplication of the vaccine strains in susceptible persons was associated with any distinct illness" [12].

A few months later, at the Institute of Health in Rome, Sabin presented a report entitled: "Results of mass vaccination with a live polio vaccine in various parts of the world"; in which he fully confirmed the positive data obtained. He added that in 1960 over 70 million people only in the USSR had already received the oral vaccine. He also announced that mass vaccination in the USA would start in March 1961. But in Italy, by contrast, nothing changed. The Minister of Health at the time, Camillo Giardina (1907-1985), by speaking in October 1960 in Rome at the International Congress of Pediatrics publicly stated that, as the sole person responsible for safeguarding public health, he would not allow Italian children to be used as guinea pigs in experiments aimed at authorizing the Sabin vaccine, which was still in the experimental phase. Thus, the vaccine was not registered in Italy, nor was its manufacture authorized for export purposes.

A few months later, on May 17, 1961, the newspaper "L'Avanti!" announced that a Polish- American scientist,

Albert Sabin, had eradicated polio in the USA, the USSR and some Eastern and European countries, while in Italy thousands of children continued to die owing to the use of an inefficacious vaccine. The front-page headline caused a political and social storm, and Italians were divided between those in favor and those against the Sabin vaccine. Those who were against the Sabin vaccine went so far as to claim that the viruses used in the Sabin vaccine, even though attenuated, immunized the recipient, but could prove dangerous for the rest of humanity. That is, the vaccine became a sort of "virus-laden bomb": a spreader of disease.

The only option therefore was to vaccinate the entire Italian population in a very short time. In fact, Sabin's vaccine induced extraordinary immunity. The attenuated virus replicated in the same way as the original virus; however, owing to the modifications made in the laboratory, it lost its ability to reach the central nervous system. Unfortunately, in one case out of 750,000, the attenuated virus "retro-mutated" as it replicated, returning to its original form. In this way, it recovered its ability to reach the central nervous system causing poliomyelitis, that was very similar to the disease caused by the "true" virus, especially in subjects with a diminished capacity to produce antibodies. For this reason, once the emergency phase of the epidemic had passed, vaccination campaigns went back to using the Salk vaccine, which, being prepared from an inactivated virus, was unable to replicate and could not therefore give rise to a retro-mutation [13, 14].

The risk was that years of research might be nullified because of an untrue and unverifiable statement. Fortunately, this did not happen, and the vaccination campaign continued. However, while the rest of the Western nations were moving towards replacing the Salk vaccine with the Sabin vaccine, Italy was still lagging behind. Only in December 1963, with the first Moro Government and Minister of Health Giacomo Mancini (1916-2002), vaccination with the Sabin vaccine began in Italy.

Given the need to proceed quickly, the Council of State authorized private negotiations to identify the company that would produce the vaccine. The choice fell upon the Tuscan Serotherapy and Vaccinogenic Institute, which had been founded 60 years earlier in Siena by Achille Sclavo (1861-1930) [15, 16], and which offered the most competitive price nationally and internationally.

The close relationship between Albert Sabin and Sclavo's Serotherapy and Vaccinogenic Institute

On inviting Sabin to a conference in Milan in 1959, Augusto Giovanardi (1904-2006), professor of Hygiene and Bacteriology and director of the Institute of Hygiene and of the Institute of Virology of the University of Milan, mentioned a small but important Italian producer of vaccines; this was the Serotherapy and Vaccinogenic Institute of Siena, which Achille Sclavo had founded in 1904 [17].

Fig. 2 Albert Sabin in a meeting with the managers of the Sclavo Institute in the early 1960s (Photo: University Museum System of Siena - SIMUS).

It should be remembered that Giovanardi's teacher, the hygienist Donato Ottolenghi, had been one of Sclavo's students, and Giovanardi himself had taught hygiene from 1938 to 1942 at the University of Siena, occupying the very chair that had been held by Achille Sclavo. He therefore knew very well the potential of the Sienese Institute of which he was a consultant.

Sabin visited the Sienese Institute several times and appreciated the high technical level achieved by the company and the constant updates implemented to create a product that complied with the regulations of the time (Fig. 2). He therefore chose the Institute to produce his vaccine and sent 50 ml of each of his three original strains to the Sclavo Institute for free, to enable the vaccine to be produced in Italy as soon as possible.

However, Minister Giardina remained wary of the Sabin vaccine and, in the newspaper "Corriere della Sera", reiterated the statement he had made a few months earlier: "The Minister of Health will never allow new medicines to be tested on the Italian population unless it has been confirmed with certainty that these drugs are not harmful" [18].

Nevertheless, work at the Sclavo Institute continued. The Minister then sent two inspectors to the Institute, who sequestered the batches of vaccine that had already been made, and ordered that production had to be suspended. The following months were very difficult for the Institute, which had invested a substantial amount of money. Meanwhile, the public was gradually becoming convinced of the efficacy of the Sabin vaccine, which was now also being used successfully in the USA.

The new Minister of Health, Angelo Raffaele Jervolino (1890-1985), set up a parliamentary commission to report to the Superior Council of Health on Sabin's vaccine. The new vaccine was accepted but was not made compulsory. As the vaccine contained live attenuated viruses, the commission also recommended to extend the treatment to all members of the vaccinee's family, who were most directly at risk of contagion by the vaccine virus [19]. As a result of the commission's report,

registration of the "Polioral" vaccine, as requested by the Sclavo Serotherapy and Vaccinogenic Institute, was authorized in September 1962 [20]. However, sale of the vaccine was not authorized until November 1963.

The Sclavo Institute's "Polioral" vaccine begins to be exported worldwide

At the beginning of 1964, production of "Polioral" – the name under which the vaccine was registered (patent N. 151731, deposited by the Tuscan Sclavo Serotherapy and Vaccinogenic Institute on 10 th September 1959 and granted on 9 th November 1960) – started in Siena and the product was marketed. The Sclavo Institute delivered the vaccines at a rate of one million doses per day, and on the 1st of March 1964, in the presence of the President of the Republic Antonio Segni (1891-1972), anti-polio vaccination with the "Sabin anti-polio vaccine" also began in Italy (Fig. 3).

Fig. 3. The Sabin oral polio vaccine is shipped worldwide from the Siena Virology Center. (Photo: University Museum System of Siena - SIMUS).

"From 3-4,000 cases annually in the 5-year period 1959-63, the number fell to 841 in 1964. Subsequently, the annual number of cases continued to decline: 254 in 1965, 148 in 1966, 107 in 1967, and 90 in 1968. In 1972, there were ten. This was a great victory for medicine, but for the Italian health service, it was a bitter lesson: no more delays or postponements" [1, 21] (Fig. 4).

Such a sensational case raises questions and underlines the lessons that history can offer. The first question certainly concerns the reasons behind the unfavorable attitude towards Sabin's vaccine – an attitude which led to a split in public opinion and, above all, a culpable delay which caused the death of thousands of people who could have been saved. According to the historian Giorgio Cosmacini, "The delay (in starting polio vaccination with the Sabin vaccine) cost Italy almost 10,000 cases of polio, which caused more than 1000 deaths and more than 8000 cases of paralysis" [1]. Indeed, in the three years that Italy waited for the Sabin vaccine, 8,431 people remained paralyzed and 1,087 died; this was the price for the Ministry's excessive caution towards the attenuated vaccine.

An important role in the decisions of the Italian Government was played by the heavy investment that the pharmaceutical companies had made in order to acquire the machinery necessary to produce the Salk vaccine, and the enormous stocks of that vaccine already available. Indeed, a sudden change of direction towards the Sabin vaccine would probably have meant that the existing stocks would have gone unused and the costs of the machinery would not have been recovered.

But in such a vital project as that of a mass vaccination campaign, efficient communication is also essential. Indeed, in 1964, Minister Mancini categorically stated that the most important factor in the success of the vaccination program was that of information. Mancini therefore supervised this phase himself, making personal appeals to health officials, doctors, mayors and

Fig. 4. Cases of polio reported in Italy between 1955 and 1972. In 1964, the year when vaccination with OPV started, the number of cases dropped from 2830 to 842 and never rose again.

the public [22]. Two thousand assistants and 11,000 care centers of the "Opera Maternità e Infanzia" came to the aid of Italian families in what was an unprecedented vaccination campaign. This mobilization enabled a great number of children and young people to be vaccinated in a short time (Fig. 5).

By 1965, the results were already evident: 254 cases occurred in the whole year, as against the annual average of 2,000 in the previous years.

Mancini engaged in an intense campaign of information and dissemination and involved famous cinema personalities as testimonials [22]. The objective of that colossal mobilization was to defeat polio.

In a few years, the number of polio cases dropped below 100, and the disease finally disappeared in 1983. This was the result of Sabin's vaccine and of a vast awareness-raising campaign. It was also the result of the efforts of the great Institute founded by Achille Sclavo, who "always proclaimed the right of Public Health to be understood as a true branch of Medicine (.). He conceived of it as preventive medicine, knowing full well that only an attentive government and an educated population (.) would enable an adequate safety threshold to be reached" [23]. Finally, credits are attributed to those who contributed to the project in many ways, such as Rotary International, which, as a founding partner of the Global Polio Eradication Iniziative, has been committed to the eradication of polio for over 35 years (Fig. 6).

Fig. 5. One of the posters prepared by the Ministry of Health (Archive of the Gruppo Anziani Sclavo).

Fig. 6. Gadget commemorating Sclavo SpA's donation of considerable quantities of vaccine for the campaign against polio in the world's poorest countries (Archive of the Gruppo Anziani Sclavo).

Conclusions

The story of the preparation and diffusion of the Sabin polio vaccine demonstrates that decisions regarding health treatments, and specifically vaccination campaigns, must be based exclusively on the results of clinical studies and on independent evaluation by the scientific community in order to ensure trust in vaccines, adequate protection of public health and well-being and to decrease citizens' vaccine hesitency.

A lesson that can be learned from the past is that we need to convey correct information on vaccines, on their effectiveness and on their possible side-effects in order to dispel citizens'; doubts and reduce so-called "vaccine hesitancy", a phenomenon that arose with the first smallpox vaccine, prepared by Edward Jenner [24, 25].

It is therefore necessary to implement what is now defined in the communications field as "prebunking"; *i.e.,* a method of forewarning people against potential disinformation and, above all, of fostering public skepticism towards fake news [26]. This also avoids the need for subsequent "debunking", *i.e.* the refutation of false information, which can generate insecurity in people and fuel further fears [27]. To achieve these objectives, and in particular vaccine hesitancy, information must be clear, accessible, impartial, and based on scientific data. It is also essential is to create a relationship of trust with citizens, through clear and consistent messages from competent institutions [28].

Effective communication in the healthcare field, in fact, must be able to support and promote, through the exchange of information between healthcare workers, patients and any other stakeholders, understanding, trust and collaboration.

For this reason it must include the involvement of patients in the decision-making process, the evaluation of health literacy levels, the guarantee of privacy, suitable time for communication, correct and properly documentation

of information and efficient and profitable use of technology skills.

In this way, healthcare professionals can create and establish strong relationships with patients, improve and develop patient satisfaction, increase patient safety, and deliver better healthcare outcomes.

To achieve these goals there are some key aspects of effective communication in healthcare: Clear and Concise Language, Active Listening, Non-Verbal Communication, Empathy and Respect, Cultural Sensitivity, Health Literacy, Use of Visual Aids, Collaborative Decision-Making, Timely and Accurate Documentation, Use of Technology that can support effective healthcare communication.

Concerning the communication techniques, the World Health Organization (WHO) has identified six key points for good communication, stating that it should be: "Accessible, Actionable, Credible, Relevant, Timely, Understandable (Fig. 7). To meet that goal, WHO focuses on communicating to and with key audiences who are the health decision makers – those agents who use WHO communications products to make a range of health decisions" [29].

"By integrating the principles of this framework into all WHO communications, we will stimulate innovation toward improved health outcomes, constantly challenging ourselves to identify better and more efficient ways to engage key audiences in communication and interaction" [29].

These suggestions can contribute to the eradication of polio ("Polio Eradication Strategy 2022-2026") [30].

The Strategy for the Eradication of Polio 2022-2026 provides an integrated approach to achieve the promised eradication objectives and, specifically, the following goals:

- create urgency and accountability to generate greater political will by re-envisioning the GPEI's relationship with governments and systematizing political advocacy;
- generate vaccine acceptance through context-adapted community engagement that reduces refusals and increases community commitment to child immunization;
- expedite progress through expanded integration efforts with a broader range of partners in immunization, essential health care and community services;
- improve frontline success through changes to campaign operations and outbreak response operations;
- enhance detection and response through sensitive surveillance that provides the programme with critical information for action [30].

Fig. 7. WHO principles for effective communications (Strategic Communications Framework for effective communications. WHO 2017.

Specifically, the Strategy for the Eradication of Polio 2022-2026 includes two goals: permanently interrupt all poliovirus transmission in endemic countries, and stop circulating vaccine-derived poliovirus (cVDPV) transmission and prevent outbreaks in non-endemic countries [30].

Indeed, massive vaccination supported by WHO, the United Nations Children's Fund (UNICEF), the US Centers for Disease Control and Prevention (CDC) and Rotary club through the Global Polio Eradication Initiative (GPEI) has reduced polio cases by 99% in industrialized countries including Italy, where polio vaccination is still provided for children, and it is included in the hexavalent vaccine (PNPV 2023-2025), with the aim to maintain the polio-free status [31].

Unfortunately, poliomyelitis disease poses a threat in countries such as Afghanistan and Pakistan where the wild type 1 (WP1) is still endemic or in countries where polio vaccination programs are not effective enough yet [32].

Vaccination therefore is a unique opportunity to stop the transmission of the virus, also considering the new vaccines under preparation [33, 34]. For this reason, it is imperative to respond positively to the scientific community's invitation to vaccinate against polio. Two great scientists of the past, Jonas Salk and Albert Sabin, made a precious gift to all the world's people, and especially the children - the hope of eradicating polio; it is a gift that should be welcomed.

And it is essential that this message is clearly conveyed by healthcare professionals. "Polio vaccination prevents the potentially life-altering effects of polio. The inter-professional healthcare team, including all clinicians (MDs - Medical Doctors, DOs - Doctor of Osteopathic Medicine, NPs - Nurse Practitioners, Pas - Physician Assistants), nursing staff, and pharmacists, must be aware that some parents may be reluctant to provide this vaccination for their children. […] By working as a team and utilizing open communication and data sharing, health professionals can educate the public about the risks and benefits of polio vaccination, overcome vaccine hesitancy, and contribute to patient and public health" [35].

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Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors' contributions

DO, MM: designed the study. DO: conceived the manuscript. DO, MM: drafted the manuscript. DO, MM, CM, LV: revised the manuscript. DO, MM LV, CM: performed a search of the literature. DO, LV, CM: critically revised the manuscript; conceptualization, and methodology, DO, MM: investigation and data curation. LV, CM, MM, DO: original draft preparation. Review all authors. LV, CM: editing. All authors have read and approved the latest version of the paper for publication.

References

[1] Cosmacini G. Storia della medicina e della sanità nell'Italia contemporanea. Roma: Laterza 1994.

[2] Martini M, Orsini D. The fight against poliomyelitis through the history: past, present and hopes for the future. Albert Sabin's missing Nobel and his "gift to all the world's children". Vaccine 2022;40:6802-5. https://doi.org/10.1016/j.vaccine.2022.09.088.

[3] The Nobel Prize in Physiology or Medicine, (year 1954). Available at: https://www.nobelprize.org/prizes/medicine/1954/summary/ (Accessed on: 28/02/2024).

[4] Trevelyan B, Smallman-Raynor M, Cliff AD. The Spatial Dynamics of Poliomyelitis in the United States: From Epidemic Emergence to Vaccine-Induced Retreat, 1910-1971. Ann Assoc Am Geogr 2005;95:269-93. https://doi.org/10.1111/j.1467-8306.2005.00460.x.

[5] Nemesis RP. Vintage. London 2010.

[6] Tan SY, Ponstein N. Jonas Salk (1914-1995): a vaccine against polio. Singapore Med J 2019;60:9-10. https://doi.org/10.11622/smedj.2019002.

[7] Offit PA. The Cutter incident, 50 years later. N Engl J Med 2005;352:1411-2. https://doi.org/10.1056/NEJMp048180.

[8] Rosselli R, Martini M, Fluad Effect Working Group, Bragazzi NL, Watad A. The public health impact of the so-called "Fluad effect" on the 2014/2015 influenza vaccination campaign in Italy: ethical implications for health-care workers and health communication practitioners. Adv Exp Med Biol 2017;973:125-34. https://doi.org/10.1007/5584_2017_39.

[9] Mahroum N, Watad A, Rosselli R, Brigo F, Chiesa V, Siri A, Ben-Ami Shor D, Martini M, Bragazzi NL, Adawi M. An infodemiological investigation of the so-called "Fluad effect" during the 2014/2015 influenza vaccination campaign in Italy: ethical and historical implications. Hum Vaccin Immunother 2018;14:712-8. https://doi.org/10.1080/21645515.2017.1420448.

[10] Martini M, Orsini D. The ghost of polio haunts us once again. The appeal of the scientific community is clear: "Vaccinate your kids today!". Vaccine 2023;41:5338-41. https://doi.org/10.1016/j.vaccine.2023.07.029.

[11] Orsini D, Martini M. Albert Bruce Sabin: The Man Who Made the Oral Polio Vaccine. Emerging Infectious Diseases 2022;28:743-46. https://doi.org/10.3201/eid2803.204699.

[12] Sabin A. Present status of field trials with an oral, live attenuated Poliovirus Vaccine. Annali Sclavo 1959;1:463.

[13] Quarleri J. Poliomyelitis is a current challenge: long-term sequelae and circulating vaccine-derived poliovirus. Geroscience 2023;45:707-7. https://doi.org/10.1007/s11357-022-00672-7.

[14] Lopalco PL. Wild and vaccine-derived poliovirus circulation, and implications for polio eradication. Epidemiol Infect 2017;145:413-9. https://doi.org/10.1017/S0950268816002569.

[15] Martini M, Orsini D. Achille Sclavo (1861-1930) and His Innovative Contributions to Italian Preventive Medicine and Healthcare Policy. Adv Exp Med Biol 2022;1369:107-16. https://doi.org/10.1007/5584_2021_673. Erratum in: Adv Exp Med Biol. 2022;1369:131-133.

[16] Orsini D, Martini M. The history of vaccinology and hygiene through Achille Sclavo and the cultural patrimony conserved in the archives and museums: the key role of medical museology. J Prev Med Hyg 2022;63:E476-481. https://doi.org/10.15167/2421-4248/jpmh2022.63.3.2622.

[17] Archivio Sabin, Lettera di A. Giovanardi a A. Sabin, 31 luglio 1959; Lettera di A. Sabin a A. Giovanardi, 8 agosto 1959, in Leoncini P, Neri P., La guerra dei vaccini. Cosa può insegnare la vicenda di Albert B. Sabin, Passigli Editori, Firenze, 2022.

[18] "Corriere della Sera", 8 agosto 1961.

[19] Atti parlamentari della Camera dei Deputati, seduta del 19 giugno 1962.

[20] Gazzetta Ufficiale della Repubblica Italiana, n. 224 del 5 settembre 1962, pp. 3622-5.

[21] Sabin A. Risultati della vaccinazione orale antipolio nel mondo. Clinica Europea 1968;VII(6).

[22] Senato della Repubblica italiana. G. Mancini e la campagna Anti-polio 1964. Serie II_s.serie 1_UA 1.

[23] Mazzetti, G. La vita e l'opera di Achille Sclavo, Siena: Tip. Istituto Vaccinogeno Toscano A. Sclavo 1949.

[24] Martini M, Bifulco M, Orsini D. Smallpox vaccination and vaccine hesitancy in the Kingdom of the Two Sicilies (1801) and the great modernity of Ferdinand IV of Bourbon: a glimpse of the past in the era of the SARS-CoV-2 (COVID-19) pandemic. Public Health 2022;213:47-53. https://doi.org/10.1016/j.puhe.2022.09.012.

[25] Parodi A, Martini M. History of vaccine and immunization: Vaccine-hesitancy discussion in Germany in XIX century.Vaccine 2023;41:1989-1993.doi:10.1016/j.vaccine.2023.02.029.

[26] MacDonald NE. SAGE Working group on Vaccine Hesitancy: Definition, scope and determinans. Vaccine 2015;33:4161-4.

[27] Orsini D, Bianucci R, Galassi FM, Lippi D, Martini M. Vaccine hesitancy, misinformation in the era of COVID-19: Lessons from the past. Ethics Med Public Health 2022;24:100812. https://doi.org/10.1016/j.jemep.2022.100812.

[28] Wolbert JG, Rajnik M, Higginbotham K. Poliomyelitis. 2024 Jan 24. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing 2024 Jan.

[29] Strategic Communications Framework for effective communications. WHO 2017. Available at: https://www.who.int/about/communications/principles (Accessed on: 01/04/2024).

[30] WHO - World Health Organization (2021). Polio Eradication Strategy 2022-2026. Delivering on a promise. Available at: https://polioeradication.org/wp-content/uploads/2021/10/9789240031937-eng.pdf (Accessed on: 27/03/2024).

[31] Ministero della Salute. Piano Nazionale di Prevenzione Vaccinale (PNPV 2023-2025). Available at: https://www.salute.gov.it/portale/vaccinazioni/dettaglioContenutiVaccinazioni.jsp?lingua=italiano&id=4828&area=vaccinazioni&menu=vuoto (Accessed on: 27/03/2024).

[32] Global Polio Eradication Initiative. Available at: https://polioeradication.org/(Accessed on: 27/03/2024).

[33] Mathur P, Kottilil S. Novel oral polio vaccine for serotype 2: new hope. Lancet Infect Dis 2024;24:223-4. https://doi.org/10.1016/S1473-3099(23)00549-2.

[34] Devaux CA, Pontarotti P, Levasseur A, Colson P, Raoult D. Is it time to switch to a formulation other than the live attenuated poliovirus vaccine to prevent poliomyelitis? Front Public Health 2024;11:1284337. https://doi.org/10.3389/fpubh.2023.1284337.

[35] O'Grady M, Bruner PJ. Polio. Vaccine 2023 Jan 16. In: StatPearls. Treasure Island, FL: StatPearls Publishing 2024.

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ERRATA CORRIGE

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Errata, Tab. V

Tab. V. Codes, subclasses and extracted classed.

Main Themes (Main domain)	Sub Themes	Codes	Nr reference
Information needs N: 48	Activity	Immobility, resources and facilities, equipment, physical and mental activities, home, group sessions, face-to-face sessions, suitable and safe places, intensity, type of movement, duration of use and appropriateness to work plans, life responsibilities, compliance with other health promotion behaviors, blood sugar control, support for adherence, having a partner, physical limitations, other comorbidities, physical ability, how to perform, security, continuity and adherence, pain control, time, duration, type of exercise and adjustment to meals, daily activities and exercise, physical-psychological effects, therapeutic, workload, work-family responsibilities	14
	Nutrition	Timing of meals, limiting portions and food groups, main food components, amount, type, blood sugar level, types of fats, psychological factors, cooking and preparing food, healthy diet, unhealthy diet, calorie measurement, adjusting diet, food label, diet adjustment, selection skill, guidelines and instructions, preparation, food and snacks, advertisements, internal temptations, work environment, food supplements	9
	Health perception	Realizing the importance, improving perception, receiving information, recognition, awareness, learning, knowing, information, knowledge, correct perception, improving perception, types of diabetes, weight loss, blood sugar and blood pressure levels, prediabetes stage, and type 2 diabetes • Symptoms and causes of developing the illness • Risk factors • Laboratory and screening tests • How to interpret them • Complications and how to control • Lifestyle change behaviors Physical fitness, diet, the results of the evidence-based measures taken, how to deal with emotions and excitement, control and management of prediabetes stage, various therapies and medical and complementary treatments, distinguishing between prediabetes and type 2 diabetes, family members, the consequences of not changing lifestyle, the methods of gaining energy, weight loss and reducing body mass index, situational conditions management, internal and external stimuli, accountability, controlling and monitoring the laboratory indicators and health status, how to use web-based programs and increase the level of electronic literacy, nutrition instructions, adherence to diet, cooking methods, physical activities, coping strategies, controlling excitement, comorbidities	22
	Medication	Therapy choices, therapeutic drugs, gaining drug information and how it is associated with lifestyle change behaviors, positive and negative effects of taking drugs and how to use them, time and purpose, patient preferences, behavioral therapies/drugs or both, improving individuals' perception of receiving natural and complementary medicines	3
Cultural needs N: 7	Cultural	Cultural factors involved, cultural barriers, cultural preferences, cultural affinity, cultural appropriateness, cultural formation, cultural tendencies and preferences, knowing the culture, social culture, work culture, family culture, correct and appropriate culture	7
Psychological needs N: 38	Self-efficacy	Inner potential and abilities, sense of individual responsibility, self-confidence, inner strength, management ability, commitment and adherence, self-management, self-efficacy, self-regulation, self-control, self-evaluation	6
	Belief, motivational, and attitudinal aspects	Positive self-talk, optimistic view, maintaining a positive perspective, paying attention to one's good mood, adjusting one's attitude, the ability to concentrate, empowering mental/emotional/psychological dimensions, strengthening inner motivation, promoting motivation, receiving rewards, correcting misbeliefs, receiving support, paying attention to tendencies, recognizing superstitions, optimistic mindset, inner stimuli	13
	Mental-psychological	Self-confidence, negative emotions, negative social labels, positive perceptions, stress, anxiety, depression, sadness, anger, adaptation skills, adaptation mechanisms, mental body image, mental image of health, negative thoughts, sources of stress, bad news	8
	Emotional	Worrying, fear, denial, panic, confusion, negative feelings, worrying and distress, feeling of numbness and lethargy, vulnerability, having power, being at risk, missing opportunities, being shocked, sadness, losing hope, being in danger, disbelief, ambiguity, danger, unclear/scattered/vague feelings, peace, support, stress	11
Social supportive needs N: 38	Treatment staff supporters	Encouraging/supportive/experienced educators, active listening skills, objective and non-judgmental, non-punitive, individual/group health instruction, guidance, follow up, feedback, involving the patient, tracking, access to facilities and training, referral, response to questions, setting personal goals, effective communication, getting motivation	16
	Support from the family, friends, and treatment staff	Support, support from the spouse, peers, family members, friends, colleagues, governmental institutions and policy makers, relatives, neighbors, peer groups (in person and virtual), family education (spouse and children), medical staff, physicians, nurses, membership in peer groups, group meetings with peers under the guidance of an educator, having a partner in preventive and health promoting activities, communication with the physician, nurses, health experts, nutritionist, receiving information	22

Corrige, Tab. V

Tab. V. Codes, subclasses, and extracted classes.

Main Themes (main domain)	Sub Themes	Codes	N. reference
Information needs N: 48	Activity	Immobility, resources and facilities, equipment, physical and mental activities, home, group sessions, face-to-face sessions, suitable and safe places, intensity, type of movement, duration of use and appropriateness to work plans, life responsibilities, compliance with other health promotion behaviors, blood sugar control, support for adherence, having a partner, physical limitations, other comorbidities, physical ability, how to perform, security, continuity and adherence, pain control, time, duration, type of exercise and adjustment to meals, daily activities and exercise, physical-psychological effects, therapeutic, workload, work-family responsibilities	14
	Nutrition	Timing of meals, limiting portions and food groups, main food components, amount, type, blood sugar level, types of fats, psychological factors, cooking and preparing food, healthy diet, unhealthy diet, calorie measurement, adjusting diet, food label, diet adjustment, selection skill, guidelines and instructions, preparation, food and snacks, advertisements, internal temptations, work environment, food supplements	9
	Health perception	Realizing the importance, improving perception, receiving information, recognition, awareness, learning, knowing, information, knowledge, correct perception, improving perception, types of diabetes, weight loss, blood sugar and blood pressure levels, prediabetes stage, and type 2 diabetes • Symptoms and causes of developing the illness • Risk factors • Laboratory and screening tests • How to interpret them • Complications and how to control • Lifestyle change behaviors Physical fitness, diet, the results of the evidence-based measures taken, how to deal with emotions and excitement, control and management of prediabetes stage, various therapies and medical and complementary treatments, distinguishing between prediabetes and type 2 diabetes, family members, the consequences of not changing lifestyle, the methods of gaining energy, weight loss and reducing body mass index, situational conditions management, internal and external stimuli, accountability, controlling and monitoring the laboratory indicators and health status, how to use web-based programs and increase the level of electronic literacy, nutrition instructions, adherence to diet, cooking methods, physical activities, coping strategies, controlling excitement, comorbidities	22
	Medication	Therapy choices, therapeutic drugs, gaining drug information and how it is associated with lifestyle change behaviors, positive and negative effects of taking drugs and how to use them, time and purpose, patient preferences, behavioral therapies/drugs or both, improving individuals' perception of receiving natural and complementary medicines	3
Cultural needs N: 7	Cultural	Cultural factors involved, cultural barriers, cultural preferences, cultural affinity, cultural appropriateness, cultural formation, cultural tendencies and preferences, knowing the culture, social culture, work culture, family culture, correct and appropriate culture	7
Psychological Needs N: 38	Self-efficacy	Inner potential and abilities, sense of individual responsibility, self-confidence, inner strength, management ability, commitment and adherence, self-management, self-efficacy, self-regulation, self-control, self-evaluation	6
	Belief, motivational, and attitudinal aspects	Positive self-talk, optimistic view, maintaining a positive perspective, paying attention to one's good mood, adjusting one's attitude, the ability to concentrate, empowering mental/emotional/psychological dimensions, strengthening inner motivation, promoting motivation, receiving rewards, correcting misbeliefs, receiving support, paying attention to tendencies, recognizing superstitions, optimistic mindset, inner stimuli	13
	Mental-psychological	Self-confidence, negative emotions, negative social labels, positive perceptions, stress, anxiety, depression, sadness, anger, adaptation skills, adaptation mechanisms, mental body image, mental image of health, negative thoughts, sources of stress, bad news	8
	Emotional	Worrying, fear, denial, panic, confusion, negative feelings, worrying and distress, feeling of numbness and lethargy, vulnerability, having power, being at risk, missing opportunities, being shocked, sadness, losing hope, being in danger, disbelief, ambiguity, danger, unclear/scattered/vague feelings, peace, support, stress	11

Social supportive needs N: 38	Treatment staff supporters	Encouraging/supportive/experienced educators, active listening skills, objective and non-judgmental, non-punitive, individual/group health instruction, guidance, follow up, feedback, involving the patient, tracking, access to facilities and training, referral, response to questions, setting personal goals, effective communication, getting motivation	16
	Support from the family, friends, and treatment staff	Support, support from the spouse, peers, family members, friends, colleagues, governmental institutions and policy makers, relatives, neighbors, peer groups (in person and virtual), family education (spouse and children), medical staff, physicians, nurses, membership in peer groups, group meetings with peers under the guidance of an educator, having a partner in preventive and health promoting activities, communication with the physician, nurses, health experts, nutritionist, receiving information	22
Educational needs N: 27	Sources of the received information Source information needs	Receiving information from an authoritative/reliable/ and scientific source, comprehensive and consistent, non-repetitive, new, up-to-date, interesting, comprehensible and simple, non-repetitive	8
	Educational sessions and programs Program-Education needs	Educational programs and sessions, neither long nor short, face-to-face, individual, containing interesting informative content and skills, neither repetitive nor ordinary, interactive, high flexibility in terms of time and place, not interfering with the work schedule, obligations and responsibilities involving other family members, maintaining privacy, group, integrated (face-to-face and virtual, individual-group), with the presence of a health educator, follow-up programs and counseling sessions, same gender, unisex, participants with many common features, mixed, collaborative, enjoyable, accessible, including peer groups, health educators, high interactive features, appropriateness to patients' positions, physical and financial abilities, paying attention to cultural and gender differences, high flexibility regarding time and place, offering appropriate choices, promoting motivation, involving individuals, family members, digital programs with proper formatting, providing electronic and video content, including reminder messages and follow-ups according to one's job & family & physical status	19
Financial needs N: 15	Financial	Commuting cost, the cost of participating in courses, government and organizational financial support, financial barriers, insurance support and coverage, low cost, free, financial resources, reasonable cost	15
Services Needs N: 17	Equipment, facilities, and services	Free, cheap, suitable, and safe means of transportation; digital and electronic services; the existence of applications, health consulting services; access to hardware and software facilities; SMS; follow-up services; video conferencing halls; clubs; walking areas; parks; sports equipment; organizations and places providing services at the community level; car parking spaces; shopping centers; laboratory and screening services; proper ventilation; suitable mattresses; referral systems; safe, covered, and near individuals' homes places	17
Skill needs N: 34	Monitoring and screening Monitoring skill needs	Blood sugar control, glucometer, how, the right time, how to interpret, blood sugar monitoring methods, digital trackers, self-monitoring	12
	Skill Management Skills needs	Forming correct lifestyle habits, the ability to deal with obstacles, preparing suitable and healthy foods, cooking, adjusting the work schedule, matching responsibilities and obligations with preventive and health-promoting behaviors, managing different situations, adjusting work and sports activities, maintaining and saving energy, time management, managing other comorbidities and accompanying physical disabilities, self-evaluation, evaluation and monitoring one's lifestyle, self-regulation and self-control, choosing appropriate and healthy nutrition	17
	Setting health goals Goal setting skill needs	Setting individual health goals; checking health status considering individual goals; updating goals; setting realistic, short-term, and achievable goals; setting goals in accordance with one's physical and clinical status and other individual limitations, setting health goals based on individual preferences and abilities	5


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