HEALTH PROMOTION

Smoking and Sport: A CrossSectional Study Among Competitive Athletes in Southern Italy. "Salento Smoke Study"

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Keywords

Athletes • Smoking • Tobacco • Cardiovascular Risk • Sport Type

Summary

Background. *Smoking habits remain prevalent even among competitive athletes, despite their well-documented negative impact on cardiovascular health and athletic performance.*

Aim. *To assess the prevalence of tobacco use among competitive athletes in a southern Italian region and explore its association with demographic characteristics, sport type, and cardiovascular risk factors.*

Materials and methods. *A cross-sectional survey was conducted among 1,348 athletes residing in the Salento peninsula (Southern Italy), with a mean age of 38.8±13.9 years. A structured questionnaire collected information on sporting activity, tobacco use, electronic nicotine delivery systems (ENDS), and cardiovascular risk factors.*

Results. *Overall, 24.4% of athletes reported smoking. Smoking prevalence was significantly higher among athletes with at least one cardiovascular risk factor compared with those without (31.2% vs. 22.1%, p=0.01). Strength athletes showed a higher prevalence of smoking than endurance athletes (31.9% vs. 17.1%, p=0.001), and athletes participating in team sports smoked more frequently than those in individual sports (34.0% vs. 19.7%, p<0.01). Smoking was more prevalent among older athletes than younger athletes (25.9% vs. 21.6%, p=0.023). ENDS were used by 10.3% of athletes; among ENDS users, a higher proportion were younger athletes (65% vs. 39%, p=0.001) and women (55% vs. 43%, p=0.02). Consistent with these findings, multivariable analysis showed that smoking was independently associated with the presence of ≥1 cardiovascular risk factor (OR 2.46), participation in team sports (OR 1.79), and older age (>35 years: OR 1.54), while endurance athletes (OR 0.62) and elite competitors (OR 0.58) exhibited lower odds of smoking.*

Conclusion. *Tobacco use remains common among competitive athletes and appears comparable to estimates from the general population. Smoking is more frequent among strength athletes and among those with cardiovascular risk factors. ENDS use is particularly widespread among younger athletes and women. These findings highlight the need for targeted cardiovascular prevention strategies even within athletic populations.*

Introduction

Several studies have reported that the prevalence of smoking among young competitive athletes ranges between 20% and 25%, with a growing preference for electronic nicotine delivery systems (ENDS) [1]. In the United States, the National College Health Assessment found similar rates of tobacco use among athletic and non-athletic college students (27.6% *vs*. 29.5%). Comparable findings were observed in South Africa, where smoking prevalence among young athletes and non-athletes was 22.2% and 18.6%, respectively [2]. Much lower rates have been reported among Olympic athletes, with a prevalence of 11.4% [3]. In Europe, as well as in Italy, nearly a quarter of the population (24%) are smokers [4]. An observational study of about 60,000 Italian athletes using a doping survey has shown the presence of nicotine in 23% of athletes [5], similar to the general population.

Cigarette smoking is well-known to be linked to an increased risk of cardiovascular disease [6-7], lung diseases such as chronic obstructive pulmonary disease (COPD) [8] and cancer [9]. Beyond its impact on morbidity and mortality, smoking negatively affects both quality of life and athletic performance. Studies on young athletes have shown that nonsmokers exhibit significantly better cardiopulmonary function during and after exercise compared with smokers [10, 11]. Exposure to passive smoking has also been associated with impaired respiratory parameters in young athletic populations [12, 13].

The prevalence of smoking is influenced by multiple factors, including the marketing strategies of the tobacco industry, national awareness campaigns, and the role of

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local institutions and educational systems [4] Moreover, smoking patterns among young people and athletes have evolved over time, particularly with the emergence of new nicotine delivery systems [20]. In this context, the present study aims to assess the prevalence of smoking among competitive athletes of all adult age groups in the Salento peninsula, a specific geographical area of southern Italy, and to explore its distinctive characteristics, including the use of traditional cigarettes and ENDS.

Materials and methods

Study design

This cross-sectional observational study was conducted at the "Cardiomed" medical and research center in Maglie (Lecce), the "MS Plan" medical center in Lecce, and the Cardiology Department of "Villa Verde" Hospital in Taranto, from March 2024 to March 2025. Competitive athletes aged 18 years or older residing in the Salento peninsula, a well-defined geographical area in southern Italy, were recruited. Participants were enrolled during routine medical evaluations required for the annual renewal of competitive sports eligibility. Only a small number of athletes declined participation, resulting in a participation rate close to 100%.

The study was approved by the Regional Ethics Committee and conducted in accordance with the Declaration of Helsinki, the Belmont Report, and International Conference on Harmonisation-Good Clinical Practice (ICH-GCP) guidelines. All participants provided written informed consent.

Each athlete completed a structured questionnaire covering demographic characteristics, medical history, type of sport, and smoking habits, including duration of use, type of product, and daily consumption. Athletes who reported smoking at least once in the previous 30 days were classified as current smokers [13]. ENDS use was classified as exclusive (use of ENDS only) or dual (combined use of ENDS and traditional cigarettes), in accordance with standard epidemiological definitions.

All demographic, clinical, and anamnestic data were entered into a dedicated database. Prevalence analyses and subgroup comparisons were then performed. Smoking prevalence was evaluated according to sport type: strength (*e.g.,* weightlifting, strongman, powerlifting), endurance (*e.g.,* cycling, running, swimming, triathlon), and mixed strength/endurance (*e.g.,* football, volleyball, basketball, tennis, boxing). Only athletes whose sporting discipline could be clearly classified as strength or endurance, or predominantly characterized by one of these two components, were included in the correlation analysis. Disciplines with overlapping characteristics were excluded from the correlation analysis.

Additional subgroup analyses included individual *vs.* team sports, sex, and competitive level (elite *vs.* amateur). Smoking habits were further characterized by type of product used (traditional cigarettes, electronic nicotine delivery systems) and quantity consumed to ensure alignment with the reported results.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 30. Descriptive statistics included continuous variables, such as age and smoking duration, which were summarized with mean and standard deviation, while categorical variables, such as sport type, sex, and smoking status, were expressed as frequencies and percentages.

For bivariate associations, the Pearson chi-square test was used to compare smoking prevalence across distinct groups, such as athletes with and without cardiovascular risk factors, strength *vs.* endurance athletes, and team *vs.* individual sport athletes. The Student's t-test was applied to compare the mean age between smokers and non-smokers. Normality assumptions for continuous variables were checked using the Shapiro-Wilk test, and Levene's test for equality of variances was conducted to ensure homogeneity of variances between groups. All continuous variables met normality assumptions.

A multivariable logistic regression analysis was performed to identify independent factors associated with smoking. The model included variables such as age group (>35 *vs.* 18-35 years), sex (male *vs.* female), sport type (team *vs.* individual), sport discipline (strength *vs.* endurance), competitive level (elite *vs.* amateur), and the presence of at least one cardiovascular risk factor. The age cut-off of 35 years was selected because, in many of the sport disciplines represented in our cohort, particularly endurance sports athletes aged ≥35 years are commonly classified within "Master" categories. This threshold therefore provides a meaningful and widely used distinction in competitive settings and allows for a more intuitive interpretation of age-related differences. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations. A two-tailed $p\text{-value}<0.05$ was considered statistically significant for all analyses.

Results

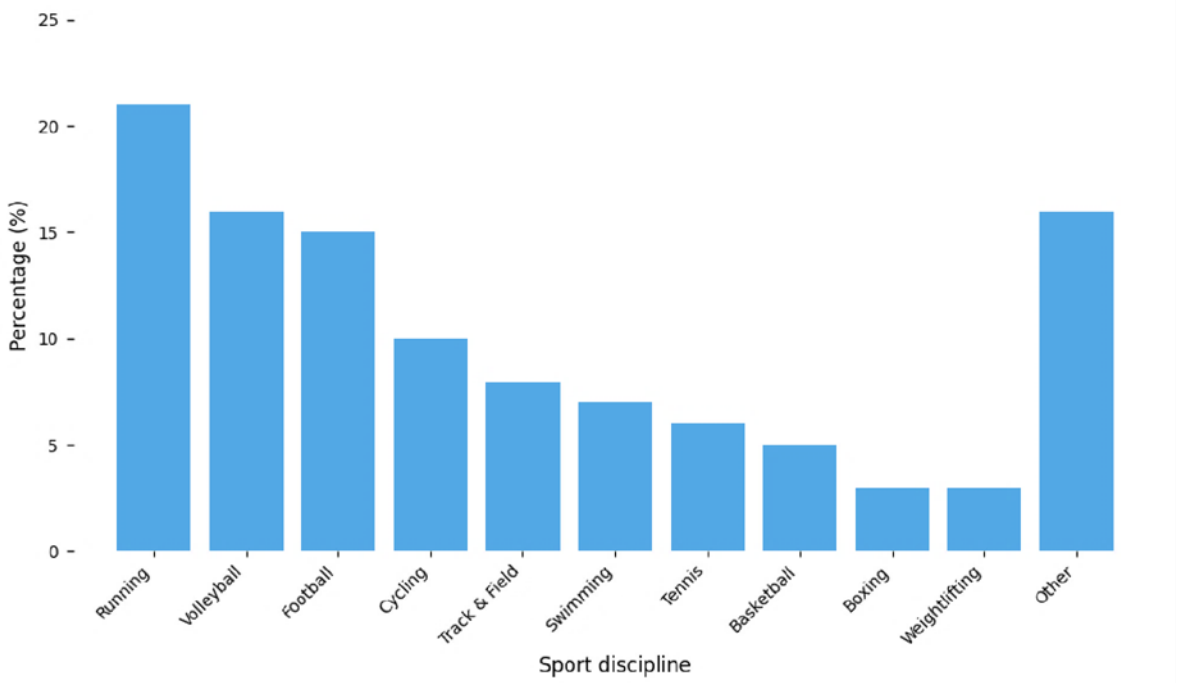
Characteristics of the population and type of sport

A total of 1,348 athletes participated in the study (Tab. I). The mean age was 38.7±13.8 years, with 964 males (71.5%) and 384 females (28.5%). The mean age of smokers was 39.1±13.7 years, compared with 38.6±13.9 years among non-smokers, with no statistically significant difference between the two groups ($p=0.42$). Athletes were divided into two age groups: younger (18-35 years, 41.5%, n=560) and older (>35 years, 58.5%, n=788).

The prevalence of each sport type is presented in Figure 1. Individual sports were more prevalent than team sports (62.3%, n=786 *vs*. 39.4%, n=497). For the analysis by sport type, only athletes whose sporting activity could be clearly classified as strength or endurance sports were included. Among these, 9.2% (n=116) participated in strength sports, and 39.7% (n=501) participated in endurance sports.

Among individual sports, running and cycling were

Fig. 1. Distribution of athletes by type of sport (N=1,348).



the most represented disciplines, while in team sports football and volleyball predominated. Overall, running, volleyball, football, cycling, and athletics together represented approximately 70% of the study population. Most athletes had a medium-level competitive profile (regional/national competitions), whereas 98 athletes (7.2%) were classified as elite or international level. Smoking was reported by 324 athletes (24.4%), while 22 athletes (1.6%) were former smokers and 1,002 (74.0%) were never smokers. Among current smokers, 176 (57%) used traditional cigarettes and 148 (43%) used electronic nicotine delivery systems (ENDS). Regarding daily cigarette consumption among smokers, 102 (58%) reported smoking fewer than 10 cigarettes per day, 60 (34%) smoked 10-20 cigarettes, and 14 (8%) smoked more than 20 cigarettes per day.

Cardiovascular risk profile of the population

The prevalence of cardiovascular risk factors in the population was as follows: hypertension in 48 athletes (3.6%), hypercholesterolemia in 64 athletes (4.7%), overweight or obesity in 36 athletes (2.7%), diabetes mellitus in 20 athletes (1.5%), a history of atrial fibrillation (AF) in 20 athletes (1.5%), and a family history of ischemic heart disease (CAD) in 64 athletes (4.7%). Overall, 282 athletes (20.9%) had at least one cardiovascular risk factor (Tab. I).

Data are presented as n (%) or mean±SD. Cardiovascular risk factors, type of sport, team *vs.* individual sport, and smoking habits are shown. Of the 1,348 athletes, 1,261 were classified into three groups based on the type of sport they practiced.

Analysis of smoking habits

Overall, 324 athletes (24.4% of the study population) were classified as current smokers, 22 (1.6%) as former smokers, and 1,002 (74.0%) as never smokers. ENDS were used by 139 athletes, corresponding to 10.3% of the total study population and 43% of current smokers. Although smoking prevalence was slightly higher among men, the difference was not statistically significant (237 men, 24.5% *vs.* 87 women, 22.6%; p=0.24).

On average, athletes started smoking at 16.9±2.9 years of age, with a mean smoking duration of 10±7 years. Regarding daily consumption, 102 smokers (58%) consumed fewer than 10 cigarettes, 60 (34%) smoked 10-20, and 14 (8%) smoked more than 20 cigarettes per day.

Associations between smoking habits and selected variables

Risk factors and smoking habits

When the smoking population was divided according to the presence of at least one cardiovascular risk factor, athletes with at least one risk factor showed a higher propensity to smoke. Among athletes without risk factors, 236/1066 (22.1%) were smokers, whereas among those with at least one risk factor, 88/282 (31.2%) were smokers. Chi-square tests confirmed that smoking prevalence was significantly higher among athletes with at least one cardiovascular risk factor compared to those without (p=0.01) (Fig. 2).

Bar chart showing the percentage of smokers and non-smokers in athletes with and without cardiovascular risk factors. Smokers are represented by the red portion, and non-smokers by the blue portion.

Tab. I. Demographic and clinical characteristics of the study population (N=1,348).

Characteristic	N (%)
Age, years	38.7±13.8
Age groups	
18–35	560 (41.5)
>35	788 (58.5)
Gender	
Male	964 (71.5)
Female	384 (28.5)
Cardiovascular risk factors	
Hypertension	48 (3.6)
Hypercholesterolemia	64 (4.7)
Overweight/Obesity	36 (2.7)
CAD family history	64 (4.7)
History of AF	20 (1.5)
Diabetes Mellitus	20 (1.5)
Type of sport	
Strength	116 (9.2)
Endurance	501 (39.7)
Strength/Endurance	644 (51.1)
Team *vs.* Individual sport	
Team	497 (39.4)
Individual	786 (62.3)
Competitive Level	
Amateur	1,263 (92.8%)
Elite	98 (7.2%)
Smoking habit	
Smokers	324 (24.4)
Former smokers	22 (1.6)
Never smokers	1002 (74.0)
Tobacco use (among smokers)	
Traditional cigarettes	176 (57)
ENDS	148 (43)
Number of cigarettes (among smokers of traditional cigarettes)	
<10	102 (58)
10-20	60 (34)
>20	14 (8)

Fig. 2. Correlation between smoking habits and cardiovascular risk factors.

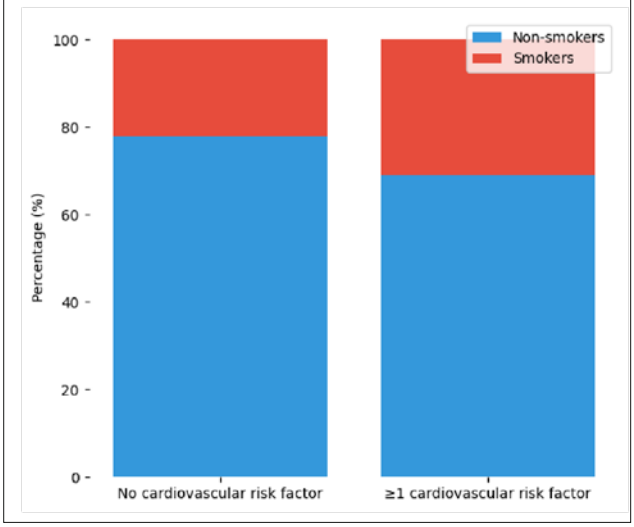
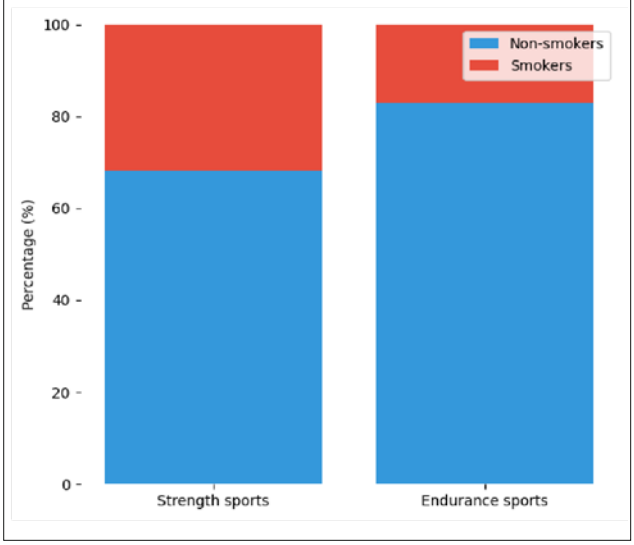


Fig. 3. Correlation between type of sport and smoking habits.



Type of sport (strength/endurance) and smoking habits

The analysis focused on the two clearly defined groups, strength and endurance athletes. Among athletes practicing strength sports, 37 out of 116 (31.9%) were current smokers. In endurance sports, smoking prevalence was significantly lower, with 85 out of 501 athletes (17.1%) reporting smoking habits. A comparison between the strength and endurance groups revealed a significant difference (31.9% *vs.* 17.1%, p=0.001), with strength athletes being more likely to smoke (Fig. 3).

Bar chart comparing the percentage of smokers and non-smokers in athletes practicing strength sports versus endurance sports. Smokers are represented by the red portion, and non-smokers by the blue portion.

Type of sport (individual or team) and smoking habits

Among athletes participating in team sports, 169 out of 497 (34.0%) were smokers, whereas 155 out of 786 (19.7%) of athletes in individual sports smoked. A statistical comparison between the two groups (individual *vs.* team sports) revealed a significant difference (p<0.01), with a higher prevalence of smoking among athletes who participate in team sports (Fig. 4).

Bar chart comparing the percentage of smokers and non-smokers in athletes practicing team or individual sports. Smokers are represented by the red portion, and non-smokers by the blue portion.

Differences in relation to age and gender and use of ENDS.

When the groups were divided by age (younger athletes, 18-35 years old, and older athletes, over 35 years old), a higher prevalence of smoking was observed in the older group: 121 athletes aged 18-35 (21.6%) and 204 athletes aged >35 (25.9%), with a statistically significant difference (p=0.023). Among smokers, a higher incidence was

Fig. 4. Distribution of smokers and non-smokers among athletes practicing team or individual sports.

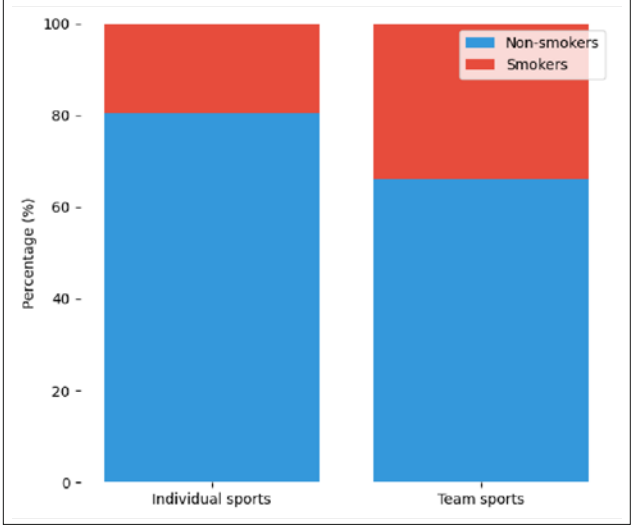
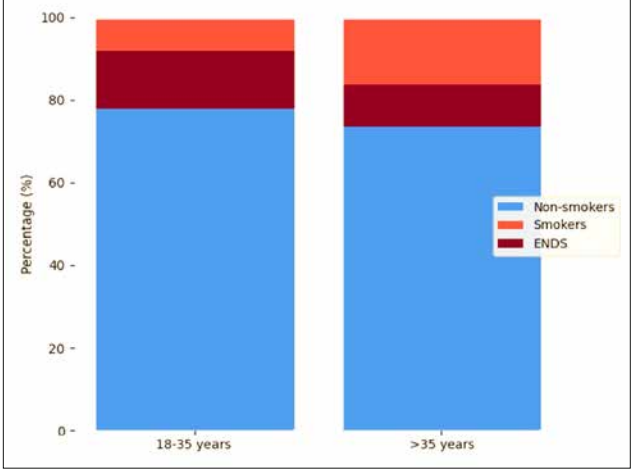


Fig. 5. Smoking habits among athletes by age, showing traditional cigarettes and electronic nicotine delivery systems (ENDS).



observed in men (n=236, 24.5%) than in women (n=88, 22.9%), although this difference was not statistically significant (p=0.248). Among current smokers, ENDS use accounted for 43% of cases and was more frequent among younger athletes (65% *vs.* 39%, p=0.001) and among women (55% *vs.* 43%, p = 0.02) (Fig. 5).

Multivariable Logistic Regression Analysis of Smoking Habits

To identify factors independently associated with current smoking status among competitive athletes, a multivariable logistic regression analysis was performed. Variables included in the model were: age group (>35 *vs.* 18-35 years), sex (male *vs.* female), type of sport (team *vs.* individual), sport discipline (strength *vs.* endurance), competitive level (elite *vs.* amateur), and presence of at least one cardiovascular risk factor. These variables were selected based on their significance in prior bivariate analyses (ttests and chisquare tests).

Tab. II. Multivariable logistic regression analysis for current smoking among competitive athletes.

Variable	OR	95% CI	*p-value*
Age >35 *vs.* 18–35 years	1.54	1.11-2.14	0.010
Male *vs.* Female	1.11	0.80-1.54	0.520
Team *vs.* Individual sport	1.79	1.28-2.50	0.001
Endurance *vs.* Strength sport	0.62	0.44-0.87	0.006
Elite *vs.* Amateur	0.58	0.39-0.86	0.007
≥1 Cardiovascular risk factor *vs.* None	2.46	1.65-3.67	<0.001

As shown in Table II, athletes with at least one cardiovascular risk factor had significantly greater odds of being current smokers compared with those without risk factors (OR=2.46, 95% CI: 1.65-3.67, p<0.001). Similarly, participation in team sports was independently associated with higher odds of smoking compared with individual sports (OR=1.79, 95% CI: 1.28-2.50, p = 0.001). Older age (>35 years) was also a significant predictor of smoking (OR=1.54, 95% CI: 1.11-2.14, p=0.01). In contrast, endurance athletes had lower odds of smoking compared with strength athletes (OR=0.62, 95% CI: 0.44-0.87, p=0.006), and elite athletes were less likely to be smokers than amateur competitors (OR=0.58, 95% CI: 0.39-0.86, p=0.007). Sex was not independently associated with smoking status (OR = 1.11, 95% CI: 0.80-1.54, p=0.52) (Fig. 6). These results confirm that the associations observed in univariate analyses persist when adjusting for multiple factors, and they highlight three key subgroups of athletes, namely those with cardiovascular risk factors, older athletes, and team sport participants, who are at an increased likelihood of smoking.

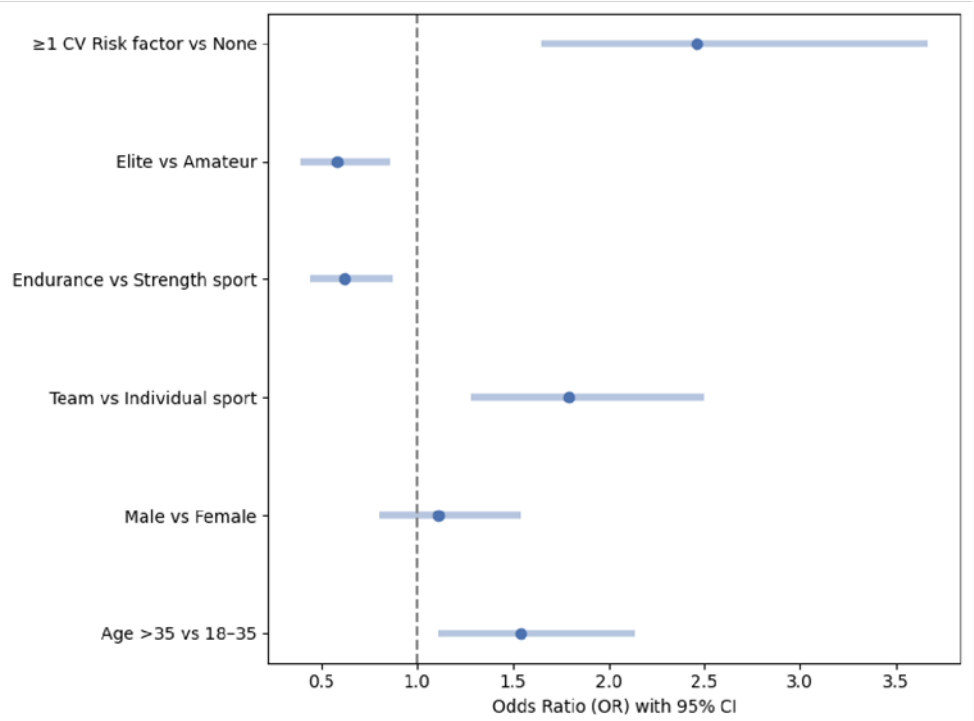
Discussion

This cross-sectional study found a relatively high prevalence of smoking among competitive athletes undergoing fitness certification in the Salento peninsula over a one-year period. The observed prevalence of current smokers (24.4%) aligns closely with estimates from the general Italian population [4, 5]. Interestingly, the subgroup of elite athletes showed a markedly lower prevalence of smoking (10.5%), consistent with data reported among Olympic-level competitors [3]. This suggests that higher-level athletes may possess greater awareness of the detrimental effects of smoking on performance and health or may be subject to stricter health monitoring and preventive measures.

Smoking and Type of Sport

Our findings indicate that athletes engaged in predominantly strength-based sports exhibited a higher prevalence of smoking compared with endurance athletes. This difference may reflect the more immediate and detrimental effects of smoking on aerobic capacity, which is crucial for endurance performance. Endurance disciplines require sustained oxygen delivery and cardiovascular efficiency, making the negative

Fig. 6. Forest plot displaying the odds ratios for factors associated with smoking among competitive athletes. Odds Ratio (OR) and 95% Confidence intervals (CI) are shown.



physiological consequences of smoking more readily apparent during training and competition [17].

Furthermore, smoking was more prevalent among athletes participating in team sports compared with individual sports, a trend supported by previous literature [18, 19]. The higher smoking rates in team sports may be influenced by social dynamics, including peer emulation, shared group behaviors, and the possibility of "masking" individual habits within a team setting. Observational studies indicate that athletes who participate in team sports multiple times per week tend to report higher tobacco use, possibly reflecting both social modeling and decreased personal accountability for performance outcomes. These findings suggest that the social environment inherent to team sports, including peer influence and shared behavioral norms, may play a relevant role in shaping smoking behaviors among athletes.

Age, Gender, and Smoking Patterns

Age at smoking initiation remains a crucial determinant of nicotine dependence and subsequent cessation success. Individuals who begin smoking before 21 years are more prone to develop dependence and less likely to quit successfully later in life [20, 21]. In our cohort, older athletes (>35 years) exhibited a higher prevalence of smoking (25.9%) compared with younger athletes (18-35 years: 21.6%), though smoking remained common among the younger group. The mean age of smoking initiation in our population was relatively early (16.9±2.9 years).

Notably, younger athletes were more likely to use electronic nicotine delivery systems (ENDS), whereas older athletes predominantly smoked traditional cigarettes. This pattern highlights the need for targeted preventive strategies focusing on youth, aimed at delaying initiation and reducing long-term nicotine dependence. Historically, male athletes have displayed higher smoking prevalence; however, gender differences have narrowed over time in many regions [24]. Our study confirmed a slightly higher propensity among men, but this difference did not reach statistical significance.

Smoking and Cardiovascular Risk Factors

Prior studies suggest that athletes may underestimate the importance of maintaining optimal lifestyle behaviors, including avoidance of tobacco [16]. Recent Italian research demonstrates that cardiovascular risk factors exist even among competitive athletes, including those at elite levels [26]. Our data show that athletes with at least one cardiovascular risk factor were significantly more likely to smoke, indicating a potential misperception of personal risk and underestimation of smoking-related cardiovascular hazards. These findings underscore the necessity of targeted educational efforts for at-risk subgroups.

Multivariable Regression: Independent Predictors of Smoking

Multivariable logistic regression allowed us to identify factors independently associated with current smoking. Athletes with at least one cardiovascular risk factor had approximately 2.5 times higher odds of being current smokers. Team sport participation and older age were also independently associated with increased smoking likelihood. Conversely, endurance athletes and elite-

level competitors exhibited lower odds of smoking. Sex was not an independent predictor in the adjusted model. These regression findings provide nuanced insights beyond univariate analyses, pinpointing high-risk subgroups; athletes with cardiovascular risk factors, older participants, and team sport athletes who may benefit most from targeted interventions. The protective role of endurance training and elite-level competition suggests that enhanced awareness of performance consequences and intensive monitoring may effectively reduce smoking prevalence.

Implications for Prevention and Health Promotion

The persistence of smoking among competitive athletes, especially those with cardiovascular risk factors, emphasizes the critical need for tailored educational and preventive strategies. Interventions should focus on risk communication, highlighting both health and performance-related consequences. In this context, team-based initiatives, age-specific programs, and individualized counseling for high-risk athletes may enhance effectiveness. Addressing ENDS use among younger athletes is particularly important to prevent early nicotine dependence and potential progression to traditional tobacco products. In organized sports settings, these findings support the implementation of targeted preventive strategies, including brief educational interventions during routine eligibility evaluations, teambased awareness initiatives, and counseling programs aimed at younger athletes and those with cardiovascular risk factors. Such approaches may help reinforce risk perception, promote healthier behaviors, and reduce both traditional cigarette use and ENDS consumption within athletic environments.

Limitations

Several limitations warrant consideration. First, the cross-sectional design precludes causal inference between smoking and observed characteristics. Second, the sample was predominantly mid-level athletes, with elite competitors underrepresented, potentially limiting generalizability. Third, ENDS use was categorized broadly without differentiation between device types, nicotine concentrations, or frequency of use. In addition, training volume, weekly exercise intensity, and total workload were not quantitatively assessed and could not be included as covariates in the statistical analyses. Moreover, although the 35-year cut-off is commonly used to distinguish Master athletes in several sport disciplines, it may not apply uniformly across all sports. Therefore, this categorization may not fully capture age-related variability in disciplines adopting different thresholds. Finally, self-reported smoking behaviors may be subject to recall and social desirability bias.

Conclusion

The primary finding of this study is the confirmation of a high prevalence of smoking among competitive athletes, comparable to the general population. Notably, smoking was more common among athletes with existing cardiovascular risk factors, underscoring a significant gap in risk perception. These results highlight the importance of implementing tailored preventive strategies within the athletic community. Educational campaigns should emphasize both performance- and health-related consequences of smoking, employing models adapted to athletes' social and competitive contexts. Interventions could include targeted programs for youth, promotion of smoke-free team environments, and personalized counseling for athletes at higher cardiovascular risk. By addressing behavioral and awareness factors, these strategies have the potential to reduce tobacco use and optimize long-term health and athletic performance.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

GDMDL, ZP, LS: Conceptualization; GDMDL, SR, ZP: Methodology; GDMLDL, MS: Formal analysis; GP, FC, AGR, GDMDL, MN, AS, GV, PP, MC, SS, LR: Investigation; GDMDL, GV: Data curation; GDMDL: Writing-original draft preparation; LS, SR, ZP: Writing-review and editing; LS, SR: Supervision. All authors have read and agreed to the published version of the manuscript.

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