

## REVIEW

# A comprehensive assessment of preconception health needs and interventions regarding women of childbearing age: a systematic review

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## Key words

Preconception health • Childbearing • Needs • Pregnancy

## Summary

**Background.** *This systematic review summarizes the preconception health needs of women in childbearing age, necessary to be addressed to have an eventual safe and healthy pregnancy.*

**Methods.** *Web of Science, PubMed and Scopus were searched. We excluded studies involving women with reproductive system pathologies and referring to interconceptive or pregnancy period and non-empirical or only abstract studies. Two researchers independently performed the blind screening based on titles/abstracts and full-text and the quality assessment.*

**Results.** *Four major domains resulted from the thematic analysis:*

*knowledge, behaviors and attitudes, health status and access to healthcare services. The most examined topics were knowledge and awareness on preconception health, folic acid assumption, tobacco and alcohol consumption, physical activity and healthy diet.*

**Conclusions.** *This review could assist healthcare professionals (physicians, nurses, midwives) in guiding tailored counselling to women to provide the adequate level of preconception care and act as a reference to policymakers.*

## Introduction

Preconception health refers to a woman's condition before she becomes pregnant. Preconception period can be defined from a biological, individual and public health point of view. From a biological perspective, it includes a critical period spanning the weeks around conception when gametes mature, fertilization occurs and the developing embryo forms. In relation to individual action, the preconception period starts whenever a woman or a couple decide they want to have a baby. From a public health perspective, the preconception period can relate to a sensitive phase in the life course, such as adolescence, when health behaviors are established, before the first pregnancy [1]. Improving preconception health and healthcare can ultimately improve pregnancy outcomes [2]. Preconception health is a broad concept including management of chronic and genetic diseases, correct nutrition, adequate consumption of folic acid, exercise, control of body weight and healthy lifestyles [3]. The first step in providing preconception care requires an understanding of women's access to health services and their knowledge of preconception risk factors. Nevertheless, sometimes, women's knowledge of preconception health is poor, especially in those who have never had or are not planning a pregnancy [4, 5]. In a study conducted among Swedish teenagers, participants recognized the relevance of preconception

health and the importance of leading a healthy lifestyle. However, not everyone had the same level of knowledge and they had difficulty understanding some aspects of preconception health. Participants expressed the need to have more information on the topic despite having heterogeneous beliefs on the methods of providing education [6].

Women may be aware of some risk factors, such as tobacco use, alcohol, drug use and domestic abuse. Nonetheless, few women discuss preconception health with their doctor [7].

Habits of women in fertile age are of utmost importance, especially among women who are not planning a pregnancy. Such women are often very young, and the lack of preconception health knowledge can lead to negative consequences on the fetus / child's development and health. It is reported that women with unintended pregnancies do not have insurance coverage, continue to smoke and to be exposed to physical violence [8]. Among these women, the recognition of pregnancy is delayed by 5 or more weeks after conception [9], which does not give them the opportunity to adopt adequate behaviors.

An important aspect during the preconception period is folic acid intake. Women who use folic acid are generally those who plan the pregnancy and request a preconception health visit from a doctor / gynecologist [10]. In fact, women are far from meeting the preconception

recommendations of folic acid intake, especially in countries without fortification requirement [11].

A fundamental role in preconception health is played by the dietary and lifestyle habits of the woman. It is highlighted how an unhealthy lifestyle, being overweight or obese favors the development of gestational diabetes mellitus [12].

However, preconception health covers a much wider spectrum, including physical, mental, emotional, and social health and not just the abovementioned aspects. This is important to understand, since in the absence of knowledge and education, women tend to perpetuate unhealthy behaviors. Given that the preconception period presents a critical window of opportunity to improve pregnancy outcomes, starting from adolescence, it is of utmost importance for public health services to know and address all women's preconception health needs. Hence, the aim of this review is to summarize the literature on preconception health needs in women of childbearing age. The focus is on behavior and factors affecting behavior, such as knowledge, attitude and access to care, that represent priority issues for a safe and healthy pregnancy outcome.

## Methods

This systematic review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [13].

The protocol of this systematic review was registered to PROSPERO, registration number CRD42020143421.

### SEARCH STRATEGY

The electronic databases of Web of Science, PubMed and Scopus were searched to look for pertinent articles. A search string was built for PubMed consisting of Medical Subject Headings (MeSH) terms and free text words. The Boolean operators were used to combine keywords such as “Women”; “Female” “Preconception”; “Preconceived” “Health”; “Healthcare”; “Medical”; “Medication”; “Dietary”; “Nutrition”; “Mental”; “Behavioral”; “Social”; “Physical”; “Environmental” “Need”; “Service”; “Demand”; “Requirement”; “Necessity”; “Determinant”; “Counseling”; “Utilization” “Assessment”; “Tool”; “Determination”; “Research”. Afterwards, this search string was adapted for the other electronic databases. The last search for all databases was performed on January 3<sup>rd</sup>, 2021 and was restricted to articles published in English, without any further restrictions.

### STUDY SELECTION AND INCLUSION/EXCLUSION CRITERIA

We included studies conducted in countries in Europe, USA, Canada, Australia and New Zealand. These areas were chosen because of their relatively homogeneous cultures and a similar vision of women and pregnancy. The criteria for inclusion focused on women's prevention behaviors and factors influencing those behaviors, such as knowledge, attitudes and access to care. We excluded

studies involving women with pathologies directly associated to the reproductive system, as well as studies referring to pregnancy and interconceptive period. Genetic screening prior to conceiving to reduce the possibility of genetic disorders goes beyond the scope of this paper. When studies included both pregnant and non-pregnant women, we presented information only for the latter. Furthermore, we excluded non-empirical studies, conference abstracts, book reviews and abstracts not accompanied by a full text. All studies retrieved from the search strategy were imported to Rayyan and duplicates were removed. Four researchers (AO, AMV, DZ, VV) independently performed the first screening based on titles and abstracts. In a second step, studies with full texts available were carefully reviewed by four researchers (AO, AM, DZ, VV) and disagreements were resolved by consensus. The reference lists of the included studies were hand searched to look for additional articles.

### DATA EXTRACTION AND SYNTHESIS

Data extraction was performed by two researchers (AO and DZ). A dedicated data extraction form was used retrieving the following information for each eligible study: (1) Study identification: first author, title, publication year; (2) Study characteristics: country, design, objective, tool used to collect information; (3) Population characteristics: sample, women's age, education level, ethnicity, setting; (4) The domain being assessed, i.e. knowledge, attitudes and behaviors, health status and access to healthcare services; (5) The specific healthcare need assessed.

Thematic analysis of each preconception health need was conducted, grouping them into four major domains: knowledge, behaviours and attitudes, health status and access to healthcare services, reporting the main findings associated to them.

### QUALITY ASSESSMENT

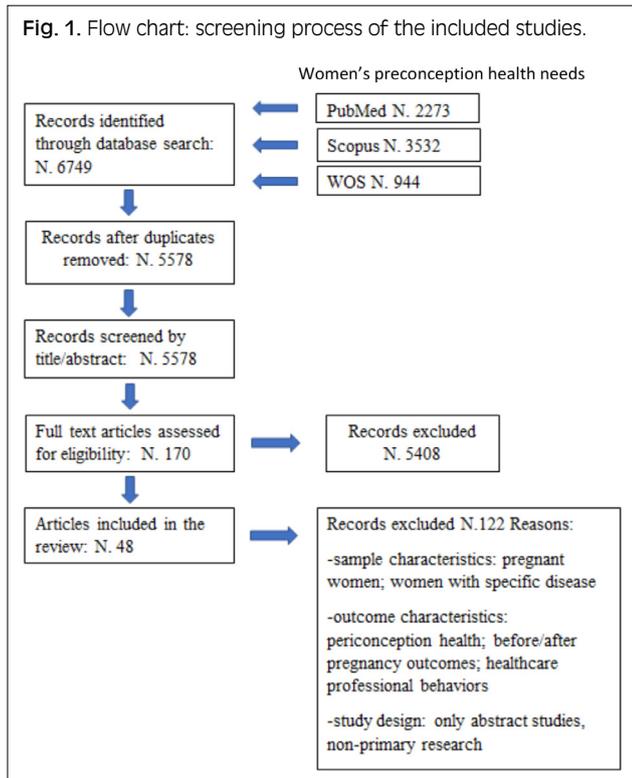
Two researchers assessed the quality of all included studies. Based on the study design, the Critical Appraisal Skills Programme for qualitative studies (CASP Qualitative Checklist, 2018), ROBINS-I for non-randomized trials [14], Jadad tool for randomized controlled trials (RCT) [15] and Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group (NIH, 2014) were used. The Newcastle-Ottawa Scale was used for cohort and case-control studies [16] and an adapted version of this scale for cross sectional studies [17].

## Results

### CHARACTERISTICS OF THE INCLUDED STUDIES

Our search strategy produced a total of 6749 articles. After the screening process 48 studies were included in the review (Fig. 1, Supplementary Tab. I.)

Among the selected studies, 22/48 were cross-sectional, 4/48 were randomized clinical trials, 7/48 were cohort studies, 3/48 were qualitative, 5/48 were pre-post studies, 2/48 were non-randomized clinical trial, 1/48



case-control studies and 4/48 were non randomized interventional study. Most of the studies were conducted in the USA (33/48), 2/48 in Poland, 2 in Italy, 2/48 in Sweden, 3/48 in Australia, 3/48 in Netherland 1/48 in Spain, 1/48 in Norway and 1/48 in Canada. Study sample of selected articles is represented by women of childbearing age between 16 and 44 years old, students and workers, of various ethnicities and social backgrounds and with different levels of education. The smallest sample enrolled 14 participants [18], and the largest 58,365 participants [19].

Results of the quality assessment reported that 23% of the studies satisfied more than 75% of the items on the rating scales and 64% of the studies satisfied between 50 and 75% of the items on the rating scales. The rest satisfied less than 50% of the items in the quality assessment scale (Supplementary Tab. II).

### KNOWLEDGE REGARDING PRECONCEPTION HEALTH

Forty three percent of the articles reported women's knowledge and 10.4% awareness on preconception health. Most studies targeted knowledge on folic acid, dietary habits and lifestyle behaviors. High awareness and knowledge on the importance of a healthy lifestyle were reported, including healthy food, normal Body Mass Index (BMI), exercise, sleeping habits, avoiding alcohol, smoking and drugs, and mental and emotional health [7, 20-26]. There was less awareness on risks deriving from the consumption of raw foods (54%), exposure to animals such as cats (64.4%), impact of genetic history and use of condoms [7]. Meanwhile a lower level of knowledge regarding folic acid and the birth defect it

helps prevent (61.9%) was reported in some studies [7, 27, 28].

Important part of the knowledge regarding preconception health concerned knowing to seek medical care for chronic conditions, and review of medication in the preconception period [23, 29, 30]. However, Italian women of childbearing age affected by autoimmune diseases reported several unmet needs in their knowledge about reproductive issues [31].

The majority of women in the study by Lammers et al. believed that preconception healthcare has a positive impact in their health, but still less than half (44.2%) were somewhat or very interested in receiving preconception healthcare [32].

Knowledge regarding taking some medical exams (such as HIV test), infectious diseases, sexually transmitted infections and immunization were also reported to play a crucial role in preconception health [7, 22, 23, 25].

For a better preconception health, of utmost importance is the information on preconception counselling, how to apply for it, when to ask for one and the health providers that may give the information [30, 33, 34].

While it was acknowledged that the best time to receive information about preconception health is before conception [7, 23], some women reported that seeking preconception care was not relevant to them if they were not planning a pregnancy [18].

### BEHAVIORS AND ATTITUDES REGARDING PRECONCEPTION HEALTH

More than 70% of studies discussed behaviors and attitudes in women of childbearing age, most of which focusing on physical activity (37%), tobacco avoidance (33%), folic acid assumption and diet (33%).

Following the recommended levels of physical activity is associated to healthy diet and weight [12, 35]. As for diabetes mellitus, while some studies have found a statistically significant association (OR 0,79, 95% CI 0.65-0.96) with physical activity [36], others have failed to do so [12]. The percentage of women that met the recommended amount of weekly physical activity went from 26% [36] to 72% [34].

Comparing women with low vs high probability for unintended pregnancy, the latter were 35% less likely to exercise [3]. Neighborhood composition and implementation of targeted interventions also influenced the level of physical activity [24] [37]. The importance of physical activity was also acknowledged by other studies [24, 25, 38-40].

Among the modifiable behaviors during the preconception period, the intake of substances and alcohol is of utmost importance. Despite the negative effects, women report alcohol consumption in the three months preceding pregnancy [10, 41], smoking during the first few months of pregnancy and in the last three months of pregnancy [41] and in the preconception period [10, 38, 42], as well as drug use [38]. The latter was reported by up to 8% of women in the month before pregnancy [43] and 25.1% during preconception [44]. Higher rates of these at-risk behaviors are seen in women in general, out

of the preconception period [9, 22] and are associated with lack of screening services and general health counseling [24], migration status [45], racial and ethnic disparities [46]. In addition, the value system and the perception of happiness symbols may influence women's health behaviors at different stages of their reproductive life [39]. Other studies have assessed behaviors of women during preconception period, reporting also the effect of educational interventions or the role of general practitioners and midwives on changing negative behaviors into positive ones [3, 23, 47].

The intention to have a pregnancy impact on preconception health. In fact, Nowicki et al report that 57.7% of women with an unplanned pregnancy, realized several weeks after conception that they were pregnant. Among these women 28.8% were smoking and 21.7% did not have any health insurance. In addition, those who reported unexpected pregnancies were victims of abuse and physical violence (10 and 7.36%, respectively) [39]. Folic acid consumption plays a crucial role in the preconception health. Despite the relevance of the topic, folic acid intake is low among women in childbearing age [10, 11, 28, 29, 38, 47]. The low levels of folic acid are due to the inappropriate eating habits, which automatically cause an inadequate supply of folic acid and lack of supplement intake [27].

Women who do not plan a pregnancy are less likely to take folic acid [38]. The use of folic acid in the preconception period is often associated with older age, a high level of education [10] and migration status [48]. The importance of folic acid consumption for preconception health was also highlighted in other studies [3, 24, 32].

As for a healthy lifestyle and diet, it is necessary to remember that the attention to the latter should not be underestimated even if a woman is not planning a pregnancy [12, 23, 24, 35, 39, 61]. The studies' results support general dietary recommendations for women of reproductive age to consume a diet rich in vegetables, whole grains, nuts, fish, low in red meats and snacks. 'Meats, snacks and sweets' diet pattern has been associated with significantly higher Gestational Diabetes Mellitus risk, while the 'Mediterranean-style' pattern with lower GDM risk [12]. Reporting any exercise or fruit/vegetable consumption was associated with decreased odds of overweight or obesity [35].

However, women of childbearing age often do not reach the recommended minimum levels of consumption of cereals, vegetables, and proteins [27, 38]. High prevalence of inadequate dietary micronutrient intake was observed for calcium (47.9%), folate (80.8%), magnesium (52.5%), potassium (63.8%) and vitamin E (78.6%) [49]. Worse dietary intakes were associated with younger age, lower education level, lower annual household income, not planning a pregnancy, obesity/overweight and smoking [42].

Among behaviors that are important for a good preconception health there were also birth control use [22-24, 32, 50-52], avoidance of exposure to toxic chemicals [24] and appropriate sleep [39].

## WOMEN'S HEALTH STATUS

Studies assessing the health status of women of childbearing age reported information on BMI (23%), mental health (10.4%), chronic and infectious diseases (14.6%) immunization (6.3%) and control of prescription drugs (6.3%).

Weight and a normal BMI play an important role in preconception health and have been associated with eating habits and physical activity [3, 10, 22, 24, 32, 38, 39, 42]. A diet composed of meats, snacks and sweets has been associated with significantly higher Gestational Diabetes Mellitus risk in parous and obese women, and in women with lower educational qualifications [12, 36, 49]. Evaluating ethnic disparities in body weight, a study in USA [46] found a higher BMI among black women (38.1%).

Mental health has an imperative role in the wellbeing of women in the preconception period [24, 39]. Women who experience any preconception stressful life events are more likely to give birth to very low birth weight infants [41]. The studies by Dunlop et al. and Denny et al. emphasize the importance of ethnicity and race on preconception mental health [23, 46].

Among the conditions to be controlled in the preconception period, there are anemia, STIs (sexually transmitted infections) pressure, diabetes [32]. However, only a small proportion of women have discussed about these conditions with their doctor [23, 32]. These women take one or more medications for their chronic conditions, often without any contraception management [52] and sometimes have low level of knowledge regarding the topic [31]. Immunization is another important variable for the health status of women in preconception period [22, 32]. Oral health in preconception care is certainly not to be underestimated. Better oral health outcomes have been reported by young women who have never had a pregnancy [53].

## ACCESSIBILITY TO HEALTH SERVICES IN PRECONCEPTION PERIOD

Women report the need to speak with their reference doctors about preconception health [8]. However, many doctors report that their patients are more likely to deal with the topic of contraceptive techniques, leaving out aspects more related to preconception health itself [30, 54]. Preconception healthcare conversation has been associated with race, health care provider type, number of visits to a health care provider, pregnancy planning [32] and educational interventions [34]. Generally, patients would prefer to receive information on preconception health from their general practitioner, but only a few of them remember having ever discussed it during a visit [7]. Women who do not plan pregnancies have a higher probability of not receiving routine physical exams, screening services and health advice [10, 9, 24].

These services include receiving a PAP test and HIV testing [3, 22, 24]. Studies in USA highlight that having health insurance during the pre-pregnancy period is associated with greater health [19, 40, 55, 56] and with variables such as ethnicity, socio-economic

conditions [56].

### **INTERVENTIONS TO ADDRESS PRECONCEPTION HEALTH NEEDS**

An intervention to address preconception health needs was reported in 37.5% of studies, and in most cases (44.4%), it was an educational one. Educational intervention increased knowledge about the benefits of folic acid [28, 29] and awareness of factors affecting preconception health, such as tobacco, alcohol, excessive weight [8, 26]. Educational intervention improved the use of prenatal vitamins (folic acid) [24, 29, 30], preconception counselling [57], addressing chronic conditions and discussing medications with a provider [23, 30], screening for sexually transmitted infections [23] use of contraception [30], diet, physical activity [24]. However, increased knowledge on folic acid and its role or contraception, was not always associated with changes in behaviors [28, 57].

Educational interventions on young population increased knowledge regarding overall preconception health and obesity, but not concerning alcohol, smoking, diabetes, or use of condoms [21] and did not demonstrate a statistically significant change in the self-reported preconception health behavior index [58].

Expanded Medicaid eligibility was associated with increased healthcare coverage and utilization, better self-rated health, and decreases in avoidance of care [19].

Use of a Web-based virtual animated health counsellor or a Risk Assessment (RA) digital tool, had an impact on participants' behaviors (18-34) [59] and increased the identification of risk factors [25]. Sending written invitations to women increased the participation of women in preconception counselling [33] and the number of women applying for a preconception consultation [34]. Individual visits by a general practitioner or a midwife increased folic acid intake, decreased the frequency of binge drinking, but had no impact on smoking [47] and increased family planning service offered to women of childbearing age [51].

Finally, a training targeting healthcare professionals increased the rates of clinicians counseling women about contraception and recommending a long-acting reversible contraceptive [54].

## **Discussion**

Preconception health includes a wide spectrum of health dimensions and cannot be comprehended without a holistic and multidisciplinary approach. The aim of this review was to comprehensively summarize the health needs of women of childbearing age, necessary to be addressed in order to have an eventual healthy pregnancy, for the woman and her child (summarized in Tab. I).

Based on the similarities among studies, health needs were divided into four categories, including knowledge and awareness on preconception health, behaviors and attitudes regarding preconception health, women's health status and access to healthcare services. Among

the most examined topics by the studies included in the review there were knowledge and awareness on preconception health, folic acid assumption, tobacco and alcohol consumption, physical activity, healthy diet and body weight.

Some studies reported a satisfactory level of knowledge and awareness concerning preconception health. Women recognized the importance of taking care of their health in anticipation of a possible pregnancy [7, 20-22, 33, 58, 59]. Knowledge was higher regarding topics like adopting a healthy lifestyle, including healthy diet, exercise, sleeping habits, and avoiding alcohol and smoking. Less was known regarding the consumption of folic acid, consumption of raw foods and impact of genetics (84.1%) [7, 25, 31, 61]. Studies concluded that educational interventions are effective in increasing knowledge on preconception health, so future interventions, especially on topics in which women have less knowledge should be implemented [18, 21-24, 26, 28-30, 57, 58]. The level of knowledge in the population is linked to the relationship with health professionals who are the main providers of health-related information. However, even though studies report a high level of knowledge and awareness and an impact of educational interventions on that, the knowledge alone or the recommendations provided by a healthcare professional are not always sufficient to change behaviors [28, 58]. Nonetheless, the positive impact of educational interventions on women's attitudes and behaviors, especially those related to nutrition and physical activity was seen in the study by Hillemeier et al. [24]. Beyond the primary role of the health professionals, public health is involved in promoting preconception care. Various strategies can be applied to this purpose, for example, schools and public health campaigns were identified by women themselves as methods for achieving greater awareness, or, similarly to the screening prevention campaigns, the use of invitation letters from the municipalities and general practitioners [18, 34]. Future longitudinal studies should focus on assessing the type of interventions that could have an impact not only on knowledge and awareness, but also on women's behaviors concerning preconception health. These interventions should be tailored to women's characteristics considering social, psychological and environmental factors that shape preconception health. A crucial role in this regard is played by health promotion which should start from early in life with a particular reinforcement in adolescence.

Among the included articles, the most studied behaviors among women of childbearing age were physical activity, tobacco avoidance and folic acid assumption. Studies acknowledged the importance of physical activity on preconception health but reported that not always women met the recommended amount of physical exercise [35, 37]. Women who have a higher probability for unintended pregnancy exercise less and neighborhood composition may play a role on preconception physical activity status. The use of alcohol and tobacco in the preconception period was not uncommon, even though their negative consequences are well known. Women who

**Tab. I.** Recommendations for healthcare professionals on preconception health.

<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Provide adequate information on risk factors during preconception period that could have a negative impact on the pregnancy and the unborn child</li> <li>• Best time for the women to receive information on preconception health</li> <li>• Who would most benefit from is preconception counselling</li> <li>• Information on multivitamin use including folic acid and NTD (neural tube defects)</li> <li>• Information on a healthy lifestyle including smoking, alcohol use, diet and physical activity</li> <li>• Information on family planning and contraception methods</li> <li>• Information on chronic diseases and medication use</li> <li>• Provide educational interventions to increase knowledge and awareness</li> </ul>
<b>Behaviors</b>	<ul style="list-style-type: none"> <li>• Promote adequate levels of physical activity</li> <li>• Promote a healthy diet</li> <li>• Promote adequate amounts of folic acid</li> <li>• Advice avoiding alcohol, tobacco and drugs use</li> <li>• Promote an appropriate number of hours of sleep, based on age and daily activities</li> <li>• Avoiding exposure to toxic chemicals</li> <li>• Provide guidance and prevention on environmental hazards</li> <li>• Advise adequate use of contraceptive techniques or fertility regulation methods</li> <li>• Promote thinking about the value of pregnancy: the perception of happiness symbols may influence women's health behavior at different stages of their reproductive life</li> <li>• Define the probability of having a pregnancy: women who have unplanned pregnancies realize their condition late and are more likely to have unhealthy behaviors, such as smoke, alcohol and drugs in the preconception period as well as after conception</li> </ul>
<b>Women's health status</b>	<ul style="list-style-type: none"> <li>• Control the weight and BMI</li> <li>• Control for chronic, genetic and infectious diseases</li> <li>• Check for sexually transmitted diseases</li> <li>• Control of prescription drugs</li> <li>• Assessment of mental health issues</li> <li>• Check the immunization status</li> </ul>
<b>Accessibility to health services</b>	<ul style="list-style-type: none"> <li>• Provide preconception health counselling to all women in childbearing age</li> <li>• Provide routine physical exams, screening services (ex. i.e. PAP test) and health advices</li> <li>• Provide a sexually transmitted disease counselling</li> <li>• Check the health coverage condition (where applicable)</li> <li>• Provide interventions to increase women's participation in preconception counselling</li> </ul>

binge drink in the preconception period are, also, more likely to smoke and be exposed to violence during this period, as well as to consume alcohol, binge drink, and smoke during pregnancy. Along with these risk factors, the consumption of marijuana is another underestimated issue that is strictly connected with the previous ones [43], but with deeper social differences: compared with tobacco users, pre-pregnancy marijuana users were more likely to have low education, low income and mental health disorders [44]. In addition, the increasing use of medical cannabis, particularly in USA, should be considered as an issue of preconception health, even if there is a gap in knowledge in the examined literature. Racial and ethnic disparities in behaviors concerning preconception health were seen in several studies [40, 46]. Women who have unintended pregnancies are more likely to engage in risky health behaviors. According to Srinivasulu et al, interventions should act in this regard also by offering family planning services [51]. Meanwhile, positive behaviors in preconception period are associated with receiving screening services and general health counselling.

As it is widely reported, the consumption of folic acid during preconception period is of utmost importance to prevent neural tubal defects [60]. However, the percentage of women who were taking folic acid in the included studies ranged from 5% [29] to 48.9% [38].

Folic acid intake is affected by pregnancy planning and is often associated with older maternal age and a high level of education. Younger women have often worse eating habits, which automatically cause an inadequate supply of folic acid [42]. Also, immigration status was negatively correlated with folic acid consumption, that, however, increased as the time of residence was lengthened, showing the importance of socio-cultural environment in changing this behavior [48]. Fortunately, simple educational intervention in preconception care can contribute to initiation of folic acid supplementation, because it is a well-accepted habit, compared to the cessation of smoking that is hard to obtain [47]. Positive health behaviors for a good preconception health include, also, birth control use [22-24, 32, 40], avoidance of exposure to toxic chemicals or teratogenic medication without proper concomitant contraception [24, 52] and appropriate sleep [39]. The existence of several risky behaviors among women of childbearing age calls for a better health promotion and public health interventions. For a pregnancy to be healthy and at low risk for both the woman and her child there is the need for the woman to be in an optimal health status before conceiving. In this context, a normal BMI, a good mental health, chronic and infectious diseases control, immunization and control of prescription drugs were the most important aspects that emerged from the studies included in the review.

Women who went through stressful events during the preconception period were more likely to have low birth weight infants [41]. This highlights that a good mental health is imperative for a healthy pregnancy. Racial and ethnic disparities were, also, important for mental health. A comprehensive assessment of a woman's health status should also include checking for anemia, STI, blood pressure, diabetes and oral health.

In order to have the right knowledge, attitude, behavior and health status women need to have access to healthcare services. Women report the necessity to speak to their reference doctors about preconception health [8, 31]. Still, many doctors state that women are more interested in discussing about contraception techniques than about preconception health in general [54]. Since most women would prefer receiving information from their doctor, the latter should not fail to discuss preconception health during consults and involve their patients in programs that provide information on this topic. Doctors should encourage women to receive the basic examinations related to preconception health like a PAP test, HIV testing and Sexually transmitted Disease Counseling. Health insurance was also deemed to be important for women's access to healthcare services. Most of the studies analyzed were actually conducted in the USA, where insurance coverage is needed to access treatment, thereby causing more ethnical and social disparities, as the preconception care is the first to be sacrificed in difficult socio-economic situations [56].

As discussed, preconception health is a wide concept, including several aspects that need a multidisciplinary approach. Integrating preconception health promotion into the continuum of women's healthcare asks for multi-dimensional and multistrategic programs involving a range of health professional expertise.

It is important that women of childbearing age have the adequate level of knowledge, adopt the right behaviors and attitudes, and have access to healthcare services in order to start a pregnancy, even when unintended, in good health. As the critical period for fetal development may extend to the preconception period, a proper management of women's health should start well before conception.

Policy makers and healthcare professionals should not fail to address all women's preconception health in a holistic and multidisciplinary way, which may ultimately improve the long-term health of women and their children.

#### IMPLICATIONS AND FUTURE RESEARCH

Preconception health care has the potential for substantial public health benefit. For this, it is important to have a holistic view of healthcare needs of women of childbearing age. This review could assist healthcare professionals (physicians, nurses, midwives) in guiding tailored counselling to provide the adequate level of preconception care to women. It could also act as a reference to policy makers in developing guidelines or policies.

This article represents the first step of a multistage project. It will be followed by the creation and validation of a questionnaire, based on the results of this review, to comprehensively assess the preconception health needs

of women of childbearing age and evaluate at what level they are met in the Italian context.

#### Ethical approvals

This systematic review has been registered in Prospero protocol; the approval of Ethical Committee was not necessary.

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None.

#### Conflict of interest statement

Authors declare no conflict of interest in the study design, data acquisition, analysis and interpretation, and writing of the manuscript.

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#### Authors' contributions

All Authors contributed in equal measure.

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Supplemental Tab. I.

Article	Study design	Used scale	Overall quality (% satisfied items)
Andreoli et al., 2019 [31]	Cross-sectional study	NOS adapted by Herzog et al.	70%
Azofeifa, 2014 [53]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Batra et al., 2018 [57]	RCT	Jadad-RCT	80%
Bello et al., 2013 [8]	Qualitative study	CASP-Qualitative studies	90%
Bello, 2018 [35]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Bickmore et al., 2019 [59]	RCT	Jadad-RCT	60%
Bromwich et al., 2020 [44]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Carmichael et al., 2019 [42]	Cohort study	NOS-CC, Cohort	46.10%
Cuervo, 2014 [38]	Cross-sectional study	NOS adapted by Herzog et al.	70%
Daw et al., 2020 [56]	Cross-sectional study	NOS adapted by Herzog et al.	60%
DeJoy et al., 2014 [58]	Pre-post study	BAQA-Pre-post studies	42%
Denny, 2012 [46]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Dunlop et al., 2013 [23]	Non randomised interventional study	ROBINS-INRC studies	50%
Flores et al., 2017 [29]	Pre-post study	BAQA-Pre-post studies	83%
Frey, 2004 [7]	Cross-sectional study	NOS adapted by Herzog et al.	40%
Głabska, 2016 [62]	Cross-sectional study	NOS adapted by Herzog et al.	50%
Harellick, 2009 [22]	Cross-sectional study	NOS adapted by Herzog et al.	50%
Hawks, 2011 [55]	Cross-sectional study	NOS adapted by Herzog et al.	70%
Hillemeier, 2008 [24]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Hillemeier et al., 2008 [5]	RCT	Jadad-RCT	60%
Hilton, 2001 [27]	Cross-sectional study	NOS adapted by Herzog et al.	20%
Kvach et al., 2018 [30]	Pre-post study	BAQA-Pre-post studies	67%
Lammers, 2010 [32]	Cross-sectional study	NOS adapted by Herzog et al.	70%
Margerison et al., 2020 [63]	Cohort study	NOS-CC, Cohort	46.10%
Moniek Looman et al., 2019 [49]	Cohort study	NOS-CC, Cohort	38.40%
Montanaro et al., 2019 [25]	Cross-sectional study	NOS adapted by Herzog et al.	70%
Murugesu et al., 2019 [33]	Qualitative study	CASP-Qualitative studies	88%
Naimi et al., 2002 [9]	Case-control study	NOS-CC, Cohort	46.10%
Nilsen et al., 2019 [48]	Cross-sectional study	NOS adapted by Herzog et al.	80%
Nilsen, 2016 [10]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Nowicki, 2018 [39]	Cross-sectional study	NOS adapted by Herzog et al.	70%
Panchal et al., 2019 [52]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Quillin et al., 2000 [28]	Pre-post study	BAQA-Pre-post studies	50%
Ragnaret al., 2018 [20]	Qualitative study	CASP-Qualitative studies	90%
Richards et al., 2012 [21]	Non randomised interventional study	ROBINS-I-NRC studies	32%
Richards et al., 2012 [21]	RCT	Jadad-RCT	20%
Schoenaker et al., 2015 [12]	Cohort study	NOS-CC, Cohort	61.30%
Short et al., 2020 [43]	Cross-sectional study	NOS adapted by Herzog et al.	80%
Sijkens et al., 2019 [34]	Interventional study	Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group.	58%
Sijkens et al., 2021 [47]	Cohort study	NOS-CC, Cohort	38.40%
Skogsdal et al., 2019 [26]	RCT	Jadad-RCT	60%
Srinivasulu et al., 2019 [51]	Interventional study	Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group.	66.60%
Stulberg et al., 2019 [54]	Pre-post study	BAQA-Pre-post studies	75%
Vamos, 2015 [37]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Walker et al., 2021 [18]	Qualitative study	CASP-Qualitative studies	77%
Whitaker et al., 2018 [36]	Cohort study	NOS-CC, Cohort	61.30%
Witt et al., 2016 [41]	Cohort study	NOS-CC, Cohort	69.20%
Xaverius, 2009 [3]	Cross-sectional study	NOS adapted by Herzog et al.	60%
Xaverius, 2012 [40]	Cross-sectional study	NOS adapted by Herzog et al.	60%

Supplemental Tab. II.

First Author, Year	Country	Design	Sample size	Women's age (years)	Setting/source	Duration	Intervention	TOOLS (test/scores/questionnaire)	Type of need assessed	Main results
Andreoli et al., 2019 [31]	Italy	Cross-sectional	398 (249 Connective Tissues Diseases, 149 Chronic Arthritis)	39.8 ± 9.21	Hospital centres	NA	NA	Self-reported questionnaire, comprising 65 multiple-choice and 12 open-answer questions	Knowledge	Nearly one third of patients declared not to have received any counselling about either pregnancy desire nor contraception. The average Disease Knowledge Index (DKI) Score for the patients who received counselling was higher than that of patients who did not receive it: 0.61 versus 0.52 for CTD ( $p = 0.09$ ) and 0.55 vs 0.44 for CA ( $P = 0.01$ ). Italian women of childbearing age affected by RD reported several unmet needs in their knowledge about reproductive issues.
Azofeifa et al., 2014 [53]	USA	Cross-sectional	3,971 nonpregnant	15-44	National Health and Nutrition Examination Survey (NHANES)	1999-2004	NA	Questionnaire	Behaviours/Health status/Oral health	The percentage of women who reported having very good or good <b>oral health</b> was significantly higher among younger nonpregnant women (75.3 vs 67.0%, $p = 0.003$ ). Non pregnant and non-Hispanic white woman (74%) with a high level of education (79%) and high socio-economic level (81%) reported having very good or good mouth and teeth condition and having a dental visit in the previous year. A higher percentage of nonpregnant women with family income greater than 200% of the FPL reported having a dental visit in the previous year compared with nonpregnant women with lower incomes (74.1 vs 52.9% for those with < 100% FPL and 74.1 vs 51.4%, for those with 100-199% FPL; $P < .001$ for both).
Batra et al., 2018[57]	USA	Cluster RCT	292	18-45	Urban academic medical center	September 2015-May 2016	Educational intervention	Questionnaire. MyFamilyPlan module online	Behaviours, access to healthcare	Participants completing the MyFamilyPlan health education module prior to a well-woman visit were significantly more likely (OR = 1.97; CI 1.22-3.19) to report that study participation led them <b>to discuss reproductive health with their physicians</b> . Exposure to MyFamilyPlan did not have an impact on <b>folic acid</b> use, <b>contraceptive</b> method initiation/change <b>self-efficacy</b> score.
Bello et al., 2018 [35]	USA	Cross-sectional	5704	18-45	National Eating Trends (NET) <sup>®</sup> Survey	2003-2011	NA	Daily diary (recordings food and beverage) Self-reported height and weight, chronic illnesses, and exercise habits	Behaviours, health status	25.5% of women were overweight and 30.7% were obese. Women of reproductive age exercised a mean of 3 days per week and consumed fruits/vegetables 9.7 times, sugar-sweetened beverages 10.7 times, and concentrated sweets 8.5 times during a 2-week period. Across BMI categories, exercise (79.2%) and eating fruits/vegetables (96.1%) were significantly associated with healthy weight Reporting any exercise or fruit/vegetable consumption was associated with decreased odds of overweight or obesity (aOR 0.73, 95% CI 0.64-0.83 and aOR 0.74, 95% CI 0.58-0.95, respectively).
Bello et al., 2013 [8]	USA	Qualitative	22	18-44	Community primary care health center for low-income African-American population	July-October 2012	Reproductive health self-assessment tool (RH-SAT)	Semi-structured interviews	Knowledge, behaviours	RH-SAT provides new information women had not previously considered about preconception health and reproductive goals. Most patients said they would feel comfortable bringing up contraception, preconception health, and their reproductive goals with their primary provider. RH-SAT could increase patient awareness and participation in discussion of these topics. Patients find reproductive goals assessment to be important and relevant to their care, but have limited knowledge.
Bickmore et al., 2020 [59]	USA	Randomized controlled trial	262	18-34	Web-based	12 months	Use of Gabby Preconception Care Conversational (PCC) intervention, a Web-based virtual animated health counsellor, to screen women on 108 preconception care risks and address them	The "Gabby" PCC agent; Six single-item scale questions to assess participants' satisfaction with the virtual counselor	Behaviours; knowledge	At the end of the year, almost all (96.4%) indicated they had either acted on recommendations made by the agent or planned to. Most (75.0%) said they would recommend the system to someone they knew. There were no significant differences between the two age groups on intervention use or satisfaction. No significant differences across usage patterns for participants based on education, employment, computer literacy or health literacy.
Bromwich et al., 2020 [44]	USA	Cross-sectional	1683	Mean 26.92	Reproductive health and maternity services centers	2014-2017	Telephone survey	Questionnaire on: 1) demographics (age, income, education, ethnicity); 2) marijuana use (before pregnancy, frequency, method, and mode of use; 3) tobacco use; 4) alcohol use	Behaviours	25.1% of respondents reported using marijuana during preconception. Marijuana users were younger, poorer, and less educated than non-users ( $p < 0.001$ ) and more likely to report alcohol use and mental illness ( $ps < 0.001$ ). Prepregnancy marijuana users, vs tobacco users, were more likely ( $< 0.001$ ) to: have low education (73 vs 66%), have low income (76 vs 66%), have mental health disorders (11.1 vs 7.1%).
Carmichael et al., 2019 [42]	USA	Cohort	11 109	All	National Birth Defects Prevention Study	1997-2011	NA	Diet Quality Index	Behaviours/Healthy lifestyle/Diet	5.1% of women were Underweight, 51.4% had a normal weight, 21.9% were overweight and 17.5% obese. Folic acid 3 months before pregnancy, No: 7042 (63.4%), Yes 3934 (35.4%). Smoked cigarettes 1 month before pregnancy, No 9106 (82.0%), Yes 1965 (17.7%). Participants who were aged < 0, were nulliparous, had < high school diploma or < \$ 20 000 annual household income, were non-Hispanic black, were underweight or obese, did not intend to become pregnant, did not take folic acid-containing vitamin supplements, or smoked had worse dietary intakes than their reference groups.

Supplemental Tab. II.

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Cuervo et al., 2014 [38]	Spain	Cross-sectional	4471	20-45	2794 pharmacies, in urban and rural areas	November 2009-March 2010	Nutritional educational intervention	Face-to-face interview	Behaviours/Health status	Only 48.9% of women were consuming folic acid (supplements or enriched food) and 14.1% multivitamins. Self-perception of health: good 66%; Self-perception of actual nutrition: very balanced 44%; tobacco: never 56.3% smoker 20.1%; alcohol yes 49%; illicit drugs 1.5% actual use; Diet supplementation: Enriched milk with calcium/vitamins 21.1% Folic acid/vitamin B12 48.9% Iodine/iodine salt 26.1% Iron 16.0% Multivitamin and minerals 14.1%; Women in preconception period did not reach the recommendation for consumption in the following food groups: proteins, cereals, salad vegetables.
Daw et al., 2020 [56]	USA	Cross-sectional	10792	19-35	Pregnancy Risk Surveillance and Monitoring System (PRAMS)	2015-2017	NA	Standardized mail and telephone survey, including demographic characteristics, insurance status, health care utilization, and health outcomes	Access to healthcare	Rate of preconception uninsurance: 9.4% (95% CI 9.0-9.8) among white non-Hispanic women. Among black non-Hispanic (12.8%, 95% CI 12.0-13.7), Hispanic English-speaking (22.3%, 95% CI 20.6-24.1), Hispanic Spanish-speaking (55.1%, 95% CI 53.0-57.1), and indigenous women (23.7%, 95% CI 21.3-26.2). In adjusted models, lower income Hispanic women and indigenous women had a significantly higher predicted probability of uninsurance in the preconception and postpartum period compared with white non-Hispanic women.
DeJoy, 2014 [58]	USA	Pre-post study	20	20-25	Public liberal arts college	4 weeks	Educational intervention	6-item index measuring preconception health knowledge 3-item index on knowledge of midwifery care; a 3-item index on knowledge of the complications of cesarean birth and preterm birth; an 8-item index measuring self-reported preconception health behaviors (multivitamin supplementation, alcohol use, exercise frequency, fruit and vegetable consumption, immunizations, contraception use, screening for HIV STIs)	Knowledge, Behaviours	After the intervention 75% of students replied that preconception health was important to them "a lot," and the remaining students stating it was "somewhat (35%). On the post-test, 75% of participants expressed a preference for midwifery care in future pregnancies. Half of participants responded that they had heard the term preconception health prior to the program, whereas 35% stated they had not and 15% were unsure. Program participants gained increased knowledge about all the covered topics but did not demonstrate a statistically significant change in the self-reported preconception health behaviour index (0.4 of 8 possible points; 95% CI, -0.4 to 1.3).
Denny et al., 2012 [46]	USA	Cohort study	54,612	18-44	Behavioral Risk Factor Surveillance System (BRFSS)	1991-1992 /2000-2001	NA	BRFSS questionnaires	Behaviours/Health status	Five risk factors examined: drinking, cigarette smoking, obesity, diabetes, and frequent mental distress. Multiple risk factors 18.7%, one risk factor 33.3%, no risk factors 48.0%. The most prevalent co-occurring risk factors was at-risk <b>drinking</b> and <b>smoking</b> (5.7%). <b>Obesity</b> (23.4%) was the most common and <b>diabetes</b> the least (5.8%). The most common combinations of risk factors were <b>smoking, obesity</b> , and frequent <b>mental distress</b> (24.3%, 95% CI 21.2-27.7). American Indian and Alaska Native women were almost 50% more likely to have multiple risk factors than white women. Women with less than a high school education were three times more likely to have multiple risk factors than women with at least a college education.
Dunlop et al., 2013 [23]	USA	Non randomised interventional study	600	18-40	Five publicly funded primary care clinics of low-income, nonpregnant African-American and Hispanic women	12 months	Targeted brief counselling (counselling + brochures). After 3-6 months women were contacted by telephone	12 item knowledge questionnaire. Reproductive and Preconception Health Risk Assessment Questionnaire	Knowledge	For women in the intervention cohort, there was a significant increase in knowledge related to the importance of screening for <b>sexually transmitted infections</b> (+12%) in the preconception period; they experienced a significant increase in knowledge related to the preconception period as the best time to seek an appointment to discuss reproductive health with a <b>provider</b> (+24%), to control <b>chronic conditions</b> (+19%), and to discuss <b>medications</b> with a provider (+20%). Among women with chronic medical conditions, those in the intervention cohort significantly increased their knowledge that the condition could lead to problems in pregnancy (p43%) relative to the lesser improvement in knowledge observed for those in the comparison cohort (p4%) (p = 0.05).

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Flores et al., 2017 [29]	USA	Pre-post study	1,446	18-45	Churches, community centers, targeted health fairs, and other locations that offer community services	4 months follow-up	Educational intervention + a 90-day supply of multivitamins	Pre and post intervention questionnaire	Knowledge/Awareness/Folic acid	<b>Folic acid</b> supplement consumption and knowledge about the benefits of folic acid increased dramatically by the end of the study, after the educational intervention ( $p < 0.0001$ ). The number of participants who reported taking vitamins every day increased (pre-test: $n = 329$ , 23%, post-test: $n = 888$ , 62%) ( $p < 0.0001$ ).
Frey, Files, 2006 [7]	USA	Cross-sectional	499	18-45	Primary care services	August 2004 and July 2005	NA	Four-page questionnaire	Knowledge/awareness	98.6% realized the importance of optimizing their health prior to a pregnancy, and realized the best time to receive information about preconception health is before conception. 95.3% preferred to receive information about preconception health from their primary care physician. Only 39% of women could recall their physician ever discussing this topic. Awareness of certain <b>risk factors</b> that are potentially affecting a pregnancy, such as tobacco (98%), alcohol (95.8%), drug use (98.8%), and domestic abuse (97.7%). Other risks: consumption of fish (54%), exposure to cat litter (64.4%), folic acid use (79.6%), medication use (97.4%), impact of genetic history (84.1%), infectious disease (89.3%).
Glabska et al., 2017 [62]	Poland	Cross-sectional	95	20-30	NA	August-December 2016	NA	Folate-Intake Calculation-Food Frequency Questionnaire (Fol-IC-FFQ). 3-Day Dietary Record	Behaviours	Adequate intake of <b>folic acid</b> with <b>diet</b> varies 15-27%. The Fol-IC-FFQ may be a valid tool for the assessment of folate intake in young women.
Harellick et al., 2011 [22]	USA	Cross-sectional	340	18-44	Two community health centers	4 weeks	NA	Healthy Babies Are Worth the Wait: 2007, Baseline Survey Pregnancy Risk Assessment Monitoring System Phase 5	Knowledge/Behaviours	70% of women reported that taking <b>folic acid</b> was beneficial, and 92% knew that <b>smoking</b> had a harmful effect. Healthcare provider's recommendations were correlated with an <b>HIV test</b> ( $\chi^2 = 24.2$ ; $p < .001$ ) and using <b>birth control</b> ( $\chi^2 = 7.6$ ; $p < .05$ ). <b>Multivitamin</b> use, drinking <b>alcohol</b> , and <b>smoking</b> were not influenced by the provider's recommendation. Correlation between presence of risk factors and respondent's knowledge existed for <b>immunizations</b> ( $\chi^2 = 9.6$ ; $p < .05$ ), but not for multivitamin use, drinking alcohol, or smoking.
Hawks et al., 2018 [55]	USA	Cross-sectional	3,929	18-40	New York City Pregnancy Risk Assessment Monitoring System	2009-2011	NA	Preconception Health Score (PHS), including healthcare worker visit, cleaning teeth, taking prenatal (folic acid containing) vitamins 3 or more times per week, access to family planning and/or birth control, drinking, smoking, BMI, physical exercise, planning for and/or trying to get pregnant, preconception visit in the last year	Access to healthcare/Health Insurance	Having <b>health insurance</b> during the pre-pregnancy period is associated with greater health among white women, but not among black or Hispanic women in New York City.
Hillemeier et al., 2008 [5]	USA	RCT	362	18-35	Low-income local rural communities	14 weeks	Educational intervention	Questionnaire, anthropometric measures, and biomarkers	Knowledge, Behaviours	Women in the intervention group had higher: <ul style="list-style-type: none"> <li>• <i>self-efficacy</i> for eating <b>healthy food</b> (OR = 1,75; <math>p = 0,008</math>) and to perceive higher <b>preconception control</b> of birth outcomes (OR = 1,916; <math>p = 0,031</math>);</li> <li>• <i>intent</i> to eat <b>healthy foods</b> and be more <b>physically active</b> (OR = 2,185; <math>p &lt; 0,001</math>);</li> <li>• <i>frequency</i> of reading food labels (OR = 2,264; <math>p = 0,001</math>), <b>physical activity</b> consistent with recommended levels (OR = 1,867; <math>p = 0,019</math>), and daily use of a <b>multivitamin with folic acid</b> (OR = 6,595; <math>p &lt; 0,001</math>).</li> </ul>

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Hillemeier et al., 2008 [24]	USA	Cross-sectional	1325	18-45	Rural region in Central Pennsylvania	2002	NA	Population-based telephone survey. Five indicators of health services use: 1. receipt of a regular physical exam, 2. obstetrician-gynecologist (ob/gyn) visit, 3. receipt of a set of recommended screening services, 4. receipt of health counseling services on general health topics, 5. receipt of pregnancy-related counseling	Access to healthcare	50% at risk of pregnancy report receiving counselling about pregnancy planning in the past year. 33% of women did not receive routine physical examinations and screening services, and over half received little or no health counselling. Having had an ob/gyn visit in the past 2 years was negatively associated with two measures of need: cardiovascular risk and lower self-rated health status. Positive health behaviour was positively associated with reported receipt of recommended screening services.
Hilton, 2002 [27]	USA	Cross-sectional	42	18-24	Small private college	NA	NA	Questionnaire assessing diet, folic acid intake and knowledge, socio economic and demographic variables	Knowledge/ Behaviours	Young women ages 18–24 often have poor dietary habits and inadequate folic acid intake. Only 33.3% reported taking daily multivitamins.
Kvach et al., 2018 [30]	USA	Pre-post study	1,677	12-45	A teaching health center in Denver, Colorado	April 2015 February 2016	Educational intervention	Routine Pregnancy Intention (PI) Screening	Knowledge/ Behaviours/ Access to healthcare	Addressing of unmet preconception health needs ( <b>prenatal vitamins, preconception counselling, addressing chronic conditions, use of contraception</b> ) increased from 47%-48% in April to 66%- 67% in July after the educational intervention.
Lammers et al., 2017 [32]	USA	Cross-sectional	868	18-45	Network of offices providing community health services	9 months	NA	Questionnaire ex novo	Knowledge/ Access to healthcare	The prevalence of <b>healthcare providers'</b> preconception healthcare (PCHC) conversations was 53.9%. Significant predictors of PCHC conversation were race (Native American 76% greater than White), health care provider type (non-physician 63% greater than physician), visits to a health care provider (3+ times 32% greater than 1–2 times), and pregnancy planning (considering in next 1-5 years 51% greater than no plans). Significant predictors of PCHC interventions received in the past 12 months were race (Native American 22% greater than White), PCHC conversation with a health care provider (yes 52% lower than no), reporting PCHC as beneficial (yes 32% greater than don't know), and visits to a health care provider in the past year (3+ times 90% greater than 1-2 times).
Margerison et al., 2020 [63]	USA	Cohort	58,365	18-44	Behavioral Risk Factor Surveillance System (BRFSS)	2018-2019	Compare the change from pre- to post-Medicaid expansion in prevalence of self-reported outcomes in <b>low-income</b> women	Self-reported questionnaire	Access to healthcare	Expanded Medicaid eligibility was associated with increased healthcare coverage and utilization, better self-rated health, and decreases in avoidance of care because of cost, heavy drinking, and binge drinking. Medicaid eligibility did not impact diagnoses of chronic conditions, smoking cessation, or BMI.
Moniek Looman et al., 2019 [49]	Australia	Cohort	277	Mean 27	Australian Longitudinal Study on Women's Health	12 years (2003-2015)		Dietary Questionnaire for Epidemiological Studies; self-report questionnaire	Behaviours	High prevalence of inadequate dietary micronutrient intake was observed for calcium (47.9%), folate (80.8%), magnesium (52.5%), potassium (63.8%) and vitamin E (78.6%). Inadequate intakes of individual micronutrients were not associated with risk of developing GDM. Women in the highest quartile of the Micronutrient Adequacy Ratio had a 39% lower risk of developing GDM compared to women in the lowest quartile (RR = 0.61, 95% CI 0.43-0.86, p = 0.01).
Montanaro et al., 2019 [25]	Canada	Cross-sectional	300	15-49	Seven primary care sites	2016	1) Implementation of a Risk Assessment (RA) digital tool. 2) Discussing results with Healthcare Providers in scheduled meetings. 3) Customized handout generated and printed in the primary care sites. 4) One-week and two-month online follow-up surveys	Risk assessment tool (RA): Body mass index; Genetic/family history; Immunizations; Infectious diseases; Medical history; Medication exposures; Mental health history; Nutrition; Oral health; Physical activity	Knowledge/ behaviours	The RA screened for 34 PCH risk factors. The number of risks identified per participant ranged from 4 to 24, averaging 15. The majority reported a positive experience using the RA and would recommend the intervention. Most prevalent risk factors identified: consumption of unsafe foods and caffeine (98%), stress in the past year (92%), consumption of alcohol in the past year (89%), and immunizations not up-to-date (87%).

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Murugesu et al., 2019 [33]	The Netherlands	Qualitative	139	18-42	General practices, mother and child healthcare centers and youth healthcare centers in low SES neighborhoods	NA	In a problem analysis (stage 1) structured interviews were used to assess comprehension of the initial invitations sent to women for preconception care, perception of perinatal risks, attitude and intention to participate in preconception counseling. Feedback was used to adapt the invitation	Interviews, telephone interviews, pre-test, post-test, Short Assessment of Health Literacy in Dutch (SAHL-D)	Knowledge	Women in stage 3 (who read the adapted flyer) had a more positive attitude towards participation in preconception counselling and a better understanding of how to apply for a consultation than women in stage 1 (who read the initial invitations). No differences were found in intention to participate in preconception counseling and risk perception. Systematic adaptation of written invitations can improve the recruitment of low health-literate women for preconception counselling.
Naimi et al., 2003 [9]	USA	Case-control study	72907	Mean age: 26	Population-based mail and telephone survey. Pregnancy Risk Assessment Monitoring System	1996/1999	NA	Population-based mail and telephone survey.	Behaviours, Access to healthcare	In preconception period, women with <b>unintended pregnancies</b> were more likely to lack <b>health insurance</b> (51.7%), <b>smoke</b> (29.8%), and be exposed to <b>physical violence</b> and have delayed pregnancy recognition (57.7%) Women with unintended pregnancies were significantly more likely to report <b>binge drinking</b> in the preconception period compared with women with intended pregnancies (16.3% vs 11.9%).
Nilsen et al., 2016 [10]	Italy	Cross-sectional	2.189	15-50	Data from seven maternity clinics located in six Italian regions	January-June, 2012	NA	Questionnaire	Behaviours/ Access to healthcare	23.5 % of the participants used <b>folic acid</b> . Of these, 93 % had taken folic acid supplements on a daily basis.. Women who both had intended their pregnancy and had requested a <b>preconception health visit</b> to a doctor/gynecologist were more likely to initiate folic acid supplementation before their pregnancy (48.6 vs 4.8 %). Preconception folic acid use was also associated with higher maternal age (28% in 35-39 years old women), higher education (31% of university graduated women), marriage /cohabitation (24%).Women who did not plan their pregnancy had a prevalence of 21.4% of preconception folic acid use.
Nilsen et al., 2019 [48]	Norway	Cross-sectional	1,055,886 (202,234 and 7,965 were 1 <sup>st</sup> and 2 <sup>nd</sup> generation immigrant women, respectively)	Mean 27-30	Medical Birth Registry of Norway (MBRN) and Statistics Norway (SSB)	1999-2016	NA	Medical Birth Registry of Norway	Behaviours	<b>Folic acid</b> supplement use: non immigrant women 29.2%; 1 <sup>st</sup> generation 25.5%; second generation (21.2%). Folic acid supplement use increased with increasing length of residence in immigrant women from most countries, but the overall prevalence was lower compared with Norwegian-born women even after 20 years of residence (AOR = 0.63; 95% CI:0.60-0.67).
Nowicki et al., 2018 [39]	Poland	Cross-sectional	182	NR	Two-way paper and pencil interview (PAPI) and computer-assisted web interviewing (CAWI)	September 2013-May 2014	NA	Paper and pencil interview (PAPI) and computer-assisted web interviewing (CAWI). Health Behaviour Inventory (HBI): 1. dietary habits; 2. prophylactics; 3. medical examination and information; 4. health practices (sleep, exercise, monitoring of body weight or past times; 5. positive mental attitude (avoidance of excessively strong emotions, stress, depressive situation). Personal Value List: value attributed to health, symbols of happiness	Behaviours, Health status Social support	HBI = 82.44 (SD = 11.80) (max = 140). <b>Healthy eating habits</b> 3.53 (0.75) (max = 5). <b>Prophylactic Behaviors</b> 3.43 (0.67) (max = 5). <b>Positive Mental Attitude</b> 3.38 (0.69) (max = 5). <b>Health Practices</b> 3.40 (0.57) (max = 5). Reasons for not having children: No employment, low income, little social support.

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Panchal et al., 2019 [52]	USA	Cross-sectional retrospective	3956	13-45	Ambulatory care family medicine residency program practices	January, 2015-December, 2015	NA	Clinical charts (reviewed for medication use and forms of birth control)	Health behaviour/ Medication use/ Contraceptive use	In a family medicine setting, 25% of women of childbearing age were prescribed at least one high-risk medication with over half not having evidence of contraception management. Women less than 25 years had decreased odds of receiving contraception when prescribed a teratogenic medication (AOR = 0.47; 95% CI, 0.34-0.66).
Quillin et al., 2000 [28]	USA	Pre-post study	71	17-50 years	College, participate in psychology groups	NA	Educational intervention on neural tube problems and prevention through folic acid	Health Belief Model (HBM) and the Fetal Health Locus of Control Scale (FHLC)	Knowledge/ Awareness/ Behaviours	Following the intervention, a significant increase in knowledge of both folic acid ( $p = 0.0001$ ) and of NTDs was found ( $p = 0.0002$ ), and there was a significant increase in scores for the perceived benefits factor ( $p = 0.0001$ ), for the perceived barriers factor ( $p = 0.0001$ ), and for the perceived threat factor ( $p = 0.0001$ ). Awareness of folic acid was not associated with multivitamin consumption.
Ragnar et al., 2018 [20]	Sweden	Qualitative	47	16-18	Upper secondary school	2015-2016	NA	Focus group interviews	Knowledge	Participants recognised the importance of preconception health and were highly aware of the importance of a healthy lifestyle. They had difficulties relating to fertility and preconception health on a personal and behavioural level. Participants wanted more information but had heterogeneous beliefs about when, where and how this information should be given. Gender roles influence beliefs about fertility and preconception health.
Richards et al., 2012 [21]	USA	Non randomised interventional study	77	11-14	Residential summer program for American Indians high school students	6 weeks	Educational interventions on youth population	Questionnaire. Lesson.	Knowledge, Behaviours	The intervention group scored higher than the non-intervention group in overall preconception health knowledge (96% vs 90%, $p = 0.03$ ) and obesity knowledge (44% vs 33%, $p = 0.01$ ). There were no significant differences in T2 scores between the intervention and non-intervention groups on knowledge of alcohol (87% vs 81%, $p = 0.33$ , smoking (76% vs 67%, $p = 0.35$ ), diabetes (72% vs 63%, $p = 0.34$ , or use of condoms (78% vs 74%, $p = 0.12$ ).
Schoenaker et al., 2015 [12]	Australia	Cohort study.	3,853	Mean 28 (1.4)	Australian Longitudinal Study on Women's Health (ALSWH)	2003/2012	NA	Survey	Behaviours/ Diet/ Health status	No associations were found for the 'Fruit and low-fat dairy' and 'Cooked vegetables' patterns and GDM. The 'Meats, snacks and sweets' pattern was associated with higher GDM risk after adjustment for socioeconomic, reproductive and lifestyle factors (RR = 1.38 [CI 1.02, 1.86]). In stratified analysis, the 'Meats, snacks and sweets' pattern was associated with significantly higher GDM risk in parous and obese women, and in women with lower educational qualifications. The 'Mediterranean-style' pattern was associated with lower GDM risk in the fully adjusted model (0.85 [0.76, 0.98]).
Short et al., 2020 [43]	USA	Cross-sectional retrospective	NR	NR	Pregnancy Risk Assessment Monitoring System (PRAMS) data from 6 states	2016	NA	Questionnaire	Behaviours/ marijuana use	8% of respondents reported that they had used marijuana in the month before pregnancy. Marital status, education level, parity, and living in a state with medical or recreational marijuana legalization or decriminalization remained independently associated with marijuana use. Those who reported marijuana use were 3-5 times more likely to also report symptoms of depression and tobacco and alcohol use before or during pregnancy than respondents who did not report marijuana use.
Sijpkens et al., 2019 [34]	The Netherlands	Interventional study	587	18-41	Primary care practices within Health Pregnancy 4 All program. Ten Dutch municipalities in deprived neighbourhoods. Target population: 165,615 women	February 2013-December 2014	Four approaches: (1) letters from municipal health services; (2) letters from general practitioners; (3) information leaflets by preventive child healthcare services and (4) encouragement by peer health educators	Questionnaires	Knowledge/ Access to healthcare	The majority of applications ( $n = 424$ ; 72%) were prompted by the invitation letters (132,129) from the municipalities and general practitioners. The effect of the municipal letter seemed to fade out after 3 months. The outreach strategy led to women with different socioeconomic backgrounds and different motivations applying for a PCC consultation.
Sijpkens et al., 2021 [47]	Netherlands	Prospective cohort	259	18-41	14 deprived municipalities selected based on their relatively high perinatal morbidity and mortality rates	3 months	2 individual visits by a general practitioner or a midwife. 1. Risk assessment and advice according to the national guideline. 2. Identified risk factors and formulated plan were evaluated	Self-reported and biomarker data on behavioral changes were obtained at baseline and 3 months later. Web-based questionnaire (including the domains lifestyle, medical, reproductive, and family history)	Behaviours/ Lifestyle	Considering the risk factors no folic acid supplementation, smoking, and alcohol consumption, 15.8% had no risk factor, 55.6% had 1 risk factors, 25.7% had 2 risk factors, and 2.9% had 3 risk factors. Baseline self-reported prevalence of no folic acid use was 36%, smoking 12%, weekly alcohol use 22%, and binge drinking 17%. 42.1% of women who reported not taking folic acid at baseline had started taking folic acid at the follow-up measurement ( $p < 0.001$ ). The percentages of smoking showed no change between baseline and follow-up. Prevalence of reported binge drinking decreased significantly ( $p = 0.007$ ).

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Skogsdal et al., 2019 [26]	Sweden	Randomized controlled trial	1,946 women Q1 and 1,198 Q2	20-40	28 outpatient clinics	February 2015-March 2016	1. Routine contraceptive counseling. 2. General information about preconception health. 3. Folic acid supplementation. 4. Information about fertility and age	Two questionnaires: at baseline (Q1) and at follow-up (Q2)	Knowledge/Awareness	Knowledge about fertility was low. After the intervention a larger proportion of women in the intervention group thought that it was more important to make lifestyle changes before a pregnancy. The intervention had great influence on if and when they will become pregnant. They also increased their awareness of factors affecting preconception health, such as to stop using tobacco, to refrain from alcohol, to be of normal weight, and to start with folic acid before a pregnancy. 76% stated that the Reproductive Life Plan Counselling should be part of the routine during visits to midwives or other healthcare providers.
Srinivasulu et al., 2020 [51]	USA	Interventional study	27,817	13-44	Institute for Family Health	March 2017-September 2018	Electronic medical record-based clinical decision support designed to increase family planning services for women of reproductive age	Clinical decision support tool	Behaviours/Family planning and contraception	Unadjusted documentation of family planning services increased by 2.7 percentage points (55.7% pre-intervention to 58.4% intervention). In the adjusted analysis, documentation increased by 3.4 percentage points (95% CI: 2.24, 4.63). Modification of effect by race, insurance, and site were substantial, but not by age group nor ethnicity. Additionally, patient-level subset analysis showed that those exposed to the intervention had 1.26 times the odds of having family planning services documented after implementation compared to controls (95% CI: 1.17-1.36).
Stulberg et al., 2019 [54]	USA	Pre-post (pilot) study	63	18-49	Urban community health center	NR	Implementation in the Electronic Medical Record of One Key Question® (would you like to become pregnant in the next year) 2. Provided a brief training to primary care clinicians on reproductive life plan assessment, preconception counseling, and contraception	Electronic Medical Records/Questionnaire	Access to healthcare/Counseling	Higher rates of <b>clinician counseling</b> women about <b>contraception</b> (52% vs 76%, $p = 0.040$ ) and recommending a long-acting reversible contraceptive (LARC) method (10% vs 32%, $p = 0.035$ ). There were no significant changes in preconception counseling.
Vamos et al., 2015 [37]	USA	Cross-sectional	7,596	18-28	80 high schools	1994-2008	NA	Questionnaire + interview	Behaviours	Older females were less likely to be <b>physically active</b> (OR 0.94, 95% CI 0.91-0.97). Population density was positively associated with more than 5 instances of Moderate-Vigorous Physical Activity (MVPA) among women (OR 1.34, 95% CI 1.02-1.77). Median household income was also positively associated with MVPA in those women (OR 1.33 95% CI 1.06-1.66). A significant inverse trend was found between high MVPA and proportion of the community without a high school diploma.
Walker et al., 2021 [18]	Australia	Qualitative	14	24-41	Community setting	September-December 2019.	NA	Interviews comprised open-ended questions to elicit their views and expectations of preconception care	Knowledge/behaviours	<ul style="list-style-type: none"> <li>Identified nutrition, physical activity and looking after their mental health as being the most important lifestyle factors for preconception health.</li> <li>Most women reported that seeking preconception care was not relevant to them if they were not planning a pregnancy.</li> <li>Only a few women could describe their experiences seeking preconception care.</li> <li>Best place to provide preconception advice: health professional with some sort of qualification.</li> <li>Women reported wanting more information about preconception health earlier in their reproductive years. Schools and public health campaigns were identified as methods of achieving greater awareness.</li> </ul>
Whitaker et al., 2018 [36]	USA	Cohort study	1333	20-35	Four field centers	1987-2010	NA	Questionnaire Coronary Artery Risk Development in Young Adults (CARDIA)	Behaviours	Women who developed <b>GDM</b> were more likely to have a family history of diabetes (21.3% $p: 0.017$ ), higher prepregnancy BMI (22.9% $p: 0.011$ ) and waist circumference (70% $p: 0.010$ ), and lower levels of fitness compared with those without GDM. Women with GDM also had worse cardiometabolic profiles, including elevated fasting glucose (70% $p: 0.010$ ), insulin (80% $p: 0.005$ ), and HOMA-IR levels and lower HDL levels (11.1% $p: 0.033$ ).
Witt et al., 2016 [41]	USA	Cohort study	9,350	20-40	Early Childhood Longitudinal Study-Birth Cohort	2001	NA	Birth certificate; self-report questionnaire about tobacco, alcohol, stressful events, prenatal health and stress	Behaviours/Health status	34.8% and 3.3% of women reported alcohol use during the three months prior to pregnancy and in the final three months of their pregnancies, respectively. 12.3% and 11.0% of women reported tobacco use during the three months prior to pregnancy and in the final three months of pregnancy, respectively. Compared to women who never smoked, women who smoked prior to conception (AOR: 1.31; 95% CI: 1.04-1.66) or during their last trimester (AOR: 1.98; 95% CI: 1.56-2.52) were more likely to give birth to LBW infants. Women who experienced any stressful life events were more likely to deliver a VLBW infant (OR = 1.73; 95% CI: 1.48-.01).

Supplemental Tab. II.

First Author, Year	Country	Design	Sample size	Women's age (years)	Setting/source	Duration	Intervention	TOOLS (test/scores/questionnaire)	Type of need assessed	Main results
Xaverius et al., 2012 [40]	USA	Cross-sectional	8,095	12-44	National Health and Nutrition Examination Survey	1996-2006	NA	Questionnaire, physical examination NHANES	Behaviours/ Access to healthcare	Non-pregnant (NP-US) women were 45% less likely to have a normal <b>BMI</b> , 1.9 times more likely to drink any <b>alcohol</b> , 2.0 times more likely to binge drink, 1.9 times more likely to <b>smoke</b> , and 3.7 times more likely to have used illicit <b>drugs</b> , 1.7 times more likely to engage in moderate <b>physical activity</b> and over 1.7 times more likely to use <b>birth control</b> than FB-US women. Non-pregnant foreign born women (NP-FB) were less likely to have <b>health insurance</b> (40.3 vs 17.2%); reported lower <b>food security</b> (78.4 vs 86.4%); were less likely to <b>own their home</b> (48.2 vs 62.4%); and were more likely to be <b>impoverished</b> (29.7 vs 17.4%).
Xaverius et al., 2009 [3]	USA	Cross-sectional	Women at high-risk (16,113) or low-risk (39,426) for pregnancy	18-44	Behavioral Risk Factor Surveillance System (BRFSS)	2002-2004	NA	Telephone survey	Behaviours/ Health status/ Access to healthcare	Women at high-risk for pregnancy were 1.23 times more likely to be <b>obese</b> (CI, 1.12-1.34) and 1.2 times more likely to <b>smoke</b> (CI, 1.11-1.31). They were 27% less likely to <b>exercise</b> (CI, 0.67-0.79), 62% less likely to receive a <b>Pap test</b> (CI, 0.31-0.46), 19% less likely to have <b>HIV testing</b> (CI, 0.75-0.87), and 44% less likely to have received <b>sexually transmitted diseases counselling</b> (CI, 0.50-0.63) compared to low-risk women. High-risk women were 27% less likely to use any <b>alcohol</b> (CI, 0.67-0.79) and 11% less likely to <b>binge drink</b> (CI, 0.80-0.99) compared with women at low-risk for an unintended pregnancy. 29% of women at risk for an unintended pregnancy are not using any <b>contraceptive method</b> .