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Enablers and barriers to preconception dietary behaviours: a mixed method study with women of reproductive age

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Abstract

Background A healthy diet before conception (preconception) diet is associated with enhanced maternal health, improved cardiometabolic outcomes, reduced risk of pregnancy complications, and effective weight management. Yet, women of reproductive age frequently exhibit suboptimal dietary behaviours before conception. We aimed to examine the enablers and barriers associated with women's adherence to healthy preconception dietary behaviours.

Methods Using sequential explanatory mixed methods, an online cross-sectional quantitative survey was followed by online qualitative interviews with women of reproductive age (18–45 years). Survey measures included the Healthy Eating Quiz (HEQ), and a pilot-tested new measure, the Preconception Diet Enablers and Barriers Scale (PDEBS) to evaluate barriers and enablers to diet. Linear regression analysed the relationship between Australian Recommended Food Score (ARFS) and barriers/enablers. Qualitative interviews were conducted to understand the reasons behind women's (non)engagement in healthy dietary habits. A weaving approach, use of joint-display, and the Capability Opportunity Motivation Behaviour (COM-B) model were used to integrate and present the data.

Results Seven hundred and eighty-eight non-pregnant women (mean [M] age 32.08 years, SD = 7.31) residing in Australia, India, and the US completed the survey. Qualitative interviews (M duration = 30 min) were conducted with 13 women based in Australia. Women's capability to maintain a healthy preconception diet was influenced by their level of knowledge and awareness of its significance. Opportunities for a healthy preconception diet were shaped by social support, time availability, financial resources, and accessibility. Additionally, motivation to adhere to a healthful preconception diet was influenced by beliefs regarding its potential outcomes, alignment with personal goals, and emotional state.

Conclusion Our findings advance understanding of the determinants influencing preconception dietary behaviours and provide valuable insights for designing effective interventions to promote healthy preconception dietary habits. By addressing the identified enablers and barriers comprehensively, policymakers, healthcare professionals, and researchers can work together to support women in adopting and maintaining healthy preconception dietary behaviours, ultimately improving maternal and child health outcomes.

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Keywords Preconception, Diet, Behaviour change, Women of reproductive age, Mixed method, Enablers, Barriers, Nutrition behaviours

Background

The preconception period, defined as the time preceding conception regardless of pregnancy intention, stands as a pivotal window of opportunity for behaviour change among women of reproductive age [1, 2]. During this phase, maternal dietary practices wield significant influence over reproductive health outcomes for both the woman and her future offspring [3]. Nutrition plays a fundamental role in optimising fertility, supporting conception, and fostering the ideal intrauterine environment necessary for fetal development, thus laying the groundwork for lifelong health trajectories [4, 5]. A healthy preconception diet has been associated with various benefits, including improved maternal health, improved cardiometabolic health [6], reduced risk of pregnancy complications such as gestational disorders of pregnancy and preterm birth, and weight management [3].

However, despite evidence of the benefits of health promoting behaviours and irrespective of their intentions regarding pregnancy, women of reproductive age often do not fully participate in adequate health practices before conception [7, 8]. For example, a systematic review examining dietary guideline adherence among preconception and pregnant women across ten countries reported that most were not meeting national dietary guidelines [9]. An Australian study included in the same review found that women attempting to conceive had an Australian Recommended Food Score (ARFS) of 29.4 suggesting suboptimal adherence to national recommendations [10]. Evidence suggests that solely having the intention to become pregnant and being motivated to improve offspring health and pregnancy outcomes are not sufficient to modify dietary behaviours before conception [8]. This highlights the necessity for a comprehensive understanding of additional factors that influence preconception dietary choices.

Despite the recognized importance of preconception nutrition, information tailored specifically for women planning pregnancy remains limited and inconsistently communicated [11, 12]. In countries such as Australia and the United States, national dietary guidelines exist but are not routinely framed for preconception period, leaving women to rely on general resources, online information of variable quality or advice from primary care providers [3, 13]. However, in countries such as India, formal preconception dietary guidance is scarce and women often depend on family traditions or sporadic advice from health workers [14, 15]. These variations in the accessibility and type of information highlight a lack of systematic support and reinforce the need to investigate the enablers and barriers shaping preconception dietary behaviours across different settings.

Research into preconception health and health behaviours is still in its early stages, especially concerning determinants related to preconception diet. In a systematic review comprising of 42 quantitative and qualitative studies investigating barriers and enablers to women's preconception health behaviours, only 10 studies specifically addressed dietary factors, with none integrating all factors together [16]. The review highlighted factors facilitating preconception diet modification such as social, family, and health worker support, awareness of its benefits, and intention to maintain healthy habits. Barriers included limited knowledge, inadequate family support, financial constraints, and lack of clear educational resources [16]. Navigating and adhering to a healthy diet during the preconception period poses significant challenges. A myriad of enablers and barriers influence dietary behaviours, shaping individuals' capacity to comply with healthy dietary requirements. It is also important to acknowledge the multifaceted nature of dietary behaviours, which are subject to influences from a diverse array of factors, ranging from social and environmental determinants to commercial forces shaping health outcomes, some of which may exceed individual control [17]. Despite this, ensuring women have the chance and autonomy to enhance their dietary behaviours before pregnancy is paramount.

Given the intricate interplay of factors influencing preconception dietary behaviours and existing studies only focusing on selected aspects of dietary behaviour change, there is a compelling imperative to comprehensively investigate the enablers and barriers for behaviour change among preconception women. Understanding these factors is crucial for developing tailored interventions aimed at promoting healthier dietary practices and improving reproductive health outcomes. By leveraging the critical preconception period as an opportunity for behaviour change, interventions can be strategically designed to address the specific needs and challenges encountered by women, thereby facilitating positive behaviour change and optimising preconception nutrition. Therefore, to gain a comprehensive understanding of factors shaping preconception diet, we used a sequential explanatory method. This approach, which integrates qualitative and quantitative methodologies, facilitated a thorough exploration of the multifaceted influences on dietary behaviours among women [18, 19]. Additionally, the adoption of the Capability, Opportunity, Motivation-Behaviour (COM-B) model provided a theoretical

framework for understanding behaviour change related to preconception diet. By applying the COM-B model at the data analysis stage, this study systematically assessed the factors influencing preconception dietary behaviours, enabling future informed development of targeted interventions to promote healthier dietary practices among preconception women. In summary, this study aimed to comprehensively investigate the enablers and barriers influencing behaviour change for preconception diet among women of reproductive age.

Methods

Study design

The study framework and analysis were guided by a sequential explanatory method, starting with an initial online cross-sectional survey followed by qualitative interviews [18, 20]. The data obtained from the online survey were used to inform the qualitative study, contributing to the ability to gain deeper insights into women's lived experiences and more comprehensive contexts for explaining and interpreting the quantitative findings. The quantitative aspect of the study complied with the relevant components of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [21] while the qualitative study adhered to the Standards for Reporting Qualitative Research (SRQR) checklist [22].

Recruitment

Survey

We conducted an online cross-sectional survey using Qualtrics, targeting preconception women [23], defined as those aged 18–45 years who were not currently pregnant. This definition included potentially unplanned pregnancies, planned pregnancies with uncertain conception times, as well as women in the interception period (time between pregnancies) and who had never been pregnant, aligning with life-course definitions of preconception [1]. Women without current plans for pregnancy were also included to capture a broader range of preconception women [1]. This is important because 44% of pregnancies worldwide are unplanned [24]. Eligibility criteria included being aged 18 to 45 years, ability to read in English, and having internet access. Women who were pregnant at the time of survey were excluded. We recruited 1346 women through social media platforms (e.g., Twitter [X], Facebook), snowballing sampling, word of mouth, emails disseminated within researchers' personal and professional networks, university newsletters, and online recruitment panels (e.g., Pureprofile). Participants were recruited via online platforms and research networks; therefore, the sample is not nationally representative of any the included countries. Implied consent was inferred from participants upon their successful completion of the online survey.

Based on analogous literature with diverse populations, we determined that a sample size of 483 was necessary to investigate the relationship between psychosocial factors, pregnancy planning, and diet, detecting a small-medium effect size (f2 = 0.04) with 80% power at an alpha level of 0.05. To increase generalisability of our findings and anticipating heterogeneity due to countries included, we deliberately recruited a larger sample, resulting in 1346 women. Most participants (93%) were from the USA, India, and Australia. Although survey responses were received from participants in multiple countries, only Australia, India, and the USA were included in the analysis. These three countries provided sufficiently large sample sizes to allow meaningful statistical analysis, while responses from other countries were too few to give reliable estimates. In addition, both Australia and the USA have articulated strategic commitments to strengthening preconception care - Australia through its inclusion in the National Obesity Strategy 2022–2032, which emphasises embedding support for healthy eating in the preconception phase [13] and the USA through longstanding Centres for Disease Control and Prevention (CDC) led national recommendations and action plans aimed at improving preconception health outcomes [25]. India provides a valuable perspective as a setting where formal preconception care remains less structured and largely unregulated, emphasizing the need to understand enablers and barriers in resource-constrained environments [26]. We excluded observations from 10 countries with very few responses (n = 52) to ensure the robustness of our analysis, yielding a final analytical sample of 788 participants. See Fig. 1 for participant flow.

Interviews

Thirteen preconception women, aged 18–45 years and not currently pregnant, were recruited for semi-structured interviews using the same recruitment methods as the survey. Eligible participants were required to read and speak English, have internet access, and reside in Australia. Women who were pregnant at the time of survey were excluded. Because barriers and enablers were similar across the countries included in the quantitative survey, and due to pragmatic reasons, qualitative surveys were conducted only in Australia. Written informed consent was obtained from all participants. Interviews were conducted by PK and EM, both women of similar ages to the participants, trained in public health, and from Asian and White backgrounds. All interviews were conducted via Zoom, audio-recorded and transcribed verbatim, with pseudonyms used to ensure participant confidentiality. On average, interviews lasted for 36 min (range:

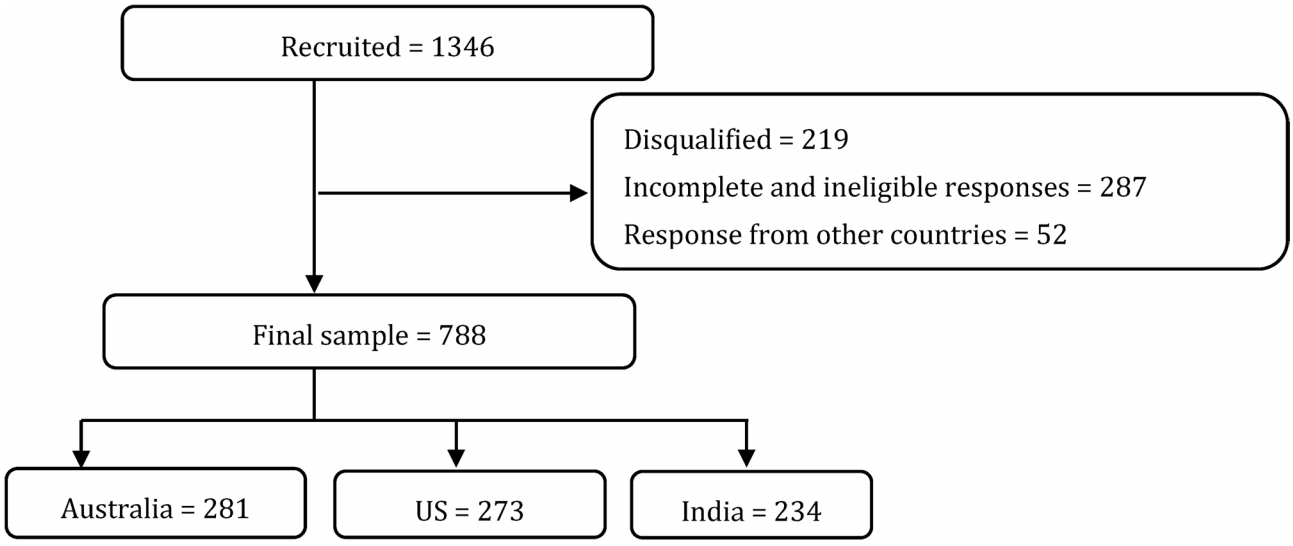

Fig. 1 Flow chart of participants

21–52 min), and data saturation guided the determination of the interview endpoint.

Study measures

Survey

Healthy Eating Quiz (HEQ): The Healthy Eating Quiz, a validated online version of the Australian Recommended Food Score (ARFS), was used to evaluate dietary habits of the participants. The ARFS comprises eight sub-scales, each associated with specific food categories: vegetables, fruit, breads and cereals, dairy, meat/flesh foods, non-meat/flesh protein foods, spreads/sauces and water [27, 28]. The score was calculated by summing the points for each item; total score ranges from 0 to 73 [29]. The score was then categorised into *needs work* (< 33), *getting there* [33–38], *excellent* [39–46] and *outstanding* (47+) according to Marshall et al. [29].

Preconception Diet Enablers and Barriers Scale (PDEBS): Given the absence of a suitable existing measure, we developed the 28-item Preconception Diet Enablers and Barriers Scale (PDEBS). Brancato et al.'s five stages of questionnaire design and testing was followed to develop the new measure [30], a process similar to development of the Preconception Physical Activity Enablers and Barriers Scale (PPEBS) [31]. Items were piloted and reliability test were performed. From the original pool of 31 items, three that were not significantly correlated were excluded. See Supplementary Table S1 for the full list of items. For the current analyses, a binary variable was created for each item by combining "strongly agree" and "agree" categories, and grouping "neither agree nor disagree," "disagree," and "strongly disagree" together. This categorisation was chosen, recognising that uncertainty typically leans towards disagreement [32].

Sociodemographic measures: We collected various self-reported sociodemographic data, including age, marital status, household composition, country of residence, educational status, paid employment status, pregnancy plans for the future, smoking behaviour, alcohol drinking behaviour, and Body Mass Index (BMI).

Interview

A semi-structured interview guide was developed (see Supplementary Table S2 for full interview guide), informed by the quantitative findings, to comprehensively explore the reasons why women may not eat a healthy diet.

Data analysis

Survey

We conducted linear regression to investigate the association between the continuous dependent variable (ARFS score) and independent variables (enablers and barriers; PDEBS). To ensure the validity of our regression analyses, we checked all relevant assumptions, including linearity, homoscedasticity, normality of residuals, and multicollinearity. Initially, we explored the bivariate relationship between ARFS score and each PDEBS statement. Subsequently, the model was adjusted for potential confounders (i.e., age, marital status, household composition, paid employment, country of residence, BMI, smoking habit, drinking habit, and pregnancy planning status) to derive the coefficient. These procedures were repeated for each individual PDEBS statement. Stata v.15 was used for analysis. For safeguarding against potential 'bot' responses and to ensure data integrity, the study implemented time-based checks, monitored IP addresses, analysed response patterns, and strategically included negatively worded statements.

Interview

Thematic analysis, following an inductive approach [33], was used to identify themed groups of both enablers and barriers. PK and MD independently coded the data, resolving any disparities through discussion. These codes were subsequently merged to construct themed groups, drawing insights from both researchers. Inter-coder reliability (ICR) was assessed using the percentage agreement/disagreement calculation to measure agreement between coders, conducted before consensus. This rigorous process aimed at ensuring a uniform interpretation and analysis of data, contributing to the validity and trustworthiness of the findings. Achieving a percentage agreement greater than 60% is considered acceptable for reliability between two coders [34]. NVivo 1.3 software was used for coding and data management.

Mixed methods integration and analysis

The integration of data involved a weaving approach, utilising joint display to facilitate interpretation and reporting. The weaving approach involves narrative integration of both quantitative and qualitative findings, organised on a theme-by-theme or concept-by-concept basis [35]. Subsequently, results were organised into a joint display, visually presenting both quantitative and qualitative findings [36, 37]. This visual representation aims to offer a more comprehensive understanding of women's responses. The COM-B model was used as a guiding framework for presenting and conceptualising data, providing a theoretical basis for understanding behaviour and its modification [38]. The main variables of interest (i.e., PDEBS and themed groupings identified in the qualitative study) were systematically aligned with the components of the COM-B model through deductive mapping via discussions among authors (PK, MD, and BH). The integrated analysis highlights the interplay of individual capabilities, social and environmental opportunities, and motivational factors in shaping dietary choices during the preconception period.

Results

The quantitative and qualitative results are outlined below, and a more extensive analysis is provided in the integration of findings section.

Survey

Participant characteristics

The characteristics of participants in the quantitative study ($n = 788$) are outlined in Table 1. The mean age of participants was 32.1 (SD 7.3) years. Half (52.8%) were married or in a de facto relationship while 48.7% were in a household composition of couple family with children. More than one third (38.4%) held a bachelor's degree and 23.7% had a master's degree or higher. More than one third (36.9%) reported never drinking alcohol and 68.8% had never smoked cigarettes. The distribution of BMI revealed that 40.1% of participants had BMI in the "normal" category. The median ARFS score was 34 (IQR: 27–42), with 43% needing work, 23.5% getting there, 20.2% excellent, and 13.3% outstanding. The PDEBS also showed that while there were some variations in the proportions of women endorsing specific barriers and enablers, across the three countries (Australia, India, and the US; Supplementary Table S3), the overall patterns of endorsement were quite similar. Consequently, countries were combined for all analyses.

Associations between ARFS score and PDEBS

Table 2 presents the results of univariable and multivariable linear regressions. In the unadjusted model, all PDEBS items showed significant positive associations with higher ARFS, including the importance of a healthy diet for both a healthy pregnancy ($\beta = 4.82$, $p = 0$) and a healthy baby ($\beta = 4.48$, $p = 0.001$). Multivariable analyses revealed that associations for the majority of statements remained significant. However, some variables, such as lack of family and friends support for eating healthy foods and knowledge about importance of healthy diets were non-significant after adjustments. Overall, the results suggest significant association between positive beliefs, behaviours, and knowledge regarding preconception nutrition and adherence to the ARFS.

Qualitative study

Demographic characteristics

Table 3 presents the demographic characteristics of women in the qualitative study. Nearly half (46.2%) of participants were in the 40–45 age group. The majority of women had planned their pregnancy and had been pregnant before. Almost two thirds (61.5%) reported having no plans for future pregnancies or being unsure, while 15.4% were currently attempting to conceive, and 23.1% were considering future conception.

Themed groups of enablers and barriers, as revealed by qualitative findings that aligned with the COM-B model, included knowledge, skills, social influence, environmental context and resources, beliefs about consequences (of not having a healthy diet), beliefs about capabilities (to eat a healthy diet), emotions, intentions, and goals. Enablers for adopting a healthy preconception diet included an awareness of its importance, skills, presence of social support, belief in its benefits, confidence, positive feelings associated with preparing and eating healthy foods, and the presence of goals. On the other hand, identified barriers included a lack of adequate information about a healthy preconception diet, concerns about the reliability of information available on social media or the internet, negative emotions related to food, prioritising

Table 1 Characteristics of participants in the quantitative study

Demographic Characteristics	Total Sample (*n* = 788)	Australia (*n* = 281)	US (*n* = 273)	India (*n* = 234)
Age in years (*n* = 768), *n* (%)				
18–24	141 (18.4)	14 (5.0)	58 (21.8)	69 (30.8)
25–34	313 (40.7)	113 (40.7)	102 (38.3)	98 (43.8)
35–45	314 (40.9)	151 (54.3)	106 (39.9)	57 (25.4)
Marital Status, *n* (%)				
Single/Never Married	332 (42.1)	79 (28.1)	144 (52.7)	109 (46.6)
Married/De facto	416 (52.8)	194 (69.0)	99 (36.3)	123 (52.5)
Divorced/Separated/Widowed	40 (5.1)	8 (2.9)	30 (11.0)	2 (0.9)
Household Composition (*n* = 786), *n* (%)				
Couple family with children	383 (48.7)	131(46.6)	106 (39.1)	146 (62.4)
Couple family without children	133 (16.9)	71 (25.3)	43 (15.9)	19 (8.1)
Group household	113 (14.4)	31 (11.0)	42 (15.5)	40 (17.1)
One parent family	67 (8.5)	16 (5.7)	35 (12.9)	16 (6.8)
Single person household	90 (11.5)	32 (11.4)	45 (16.6)	13 (5.6)
Educational Status (*n* = 786), *n* (%)				
High School not completed	98 (12.5)	8 (2.9)	77 (28.3)	13 (5.6)
High School Graduate/Diploma	100 (12.7)	25 (8.9)	61 (22.4)	14 (6.0)
Trade/Vocational/Associate degree	100 (12.7)	58 (20.7)	37 (13.6)	5 (2.1)
Bachelor's degree	302 (38.4)	109 (38.9)	70 (25.7)	123 (52.5)
Masters and above	186 (23.7)	80 (28.6)	27 (10.0)	79 (33.8)
Paid employment (*n* = 788), *n* (%)				
Yes	563 (71.4)	230 (81.8)	163 (59.7)	170 (72.6)
No	225 (28.6)	51 (18.2)	110 (40.3)	64 (27.4)
Pregnancy plans for future (*n* = 787), *n* (%)				
Considering in next 1 or 2 years	131 (16.7)	51 (18.2)	40 (14.7)	40 (17.1)
Considering in next 3 to 5 years	100 (12.7)	31 (11.0)	39 (14.3)	30 (12.8)
Currently trying to conceive	54 (6.9)	21 (7.5)	15 (5.5)	18 (7.7)
Have completed my family	76 (9.7)	43 (15.3)	22 (8.1)	11 (4.7)
Tried and unable to get pregnant	20 (2.5)	4 (1.4)	12 (4.4)	4 (1.7)
No plans/Not sure/Prefer not to answer	406 (51.6)	131 (46.6)	144 (53.0)	131 (56.0)
Smoking habit (*n* = 786), *n* (%)				
Never smoked cigarettes	541 (68.8)	200 (71.2)	152 (56.1)	189 (80.8)
Currently smoking	113 (14.4)	26 (9.2)	72 (26.6)	15 (6.4)
Smoked in past	132 (16.8)	55 (19.6)	47 (17.3)	30 (12.8)
Drinking habit (*n* = 787), *n* (%)				
1–3 times a week	194 (24.6)	81 (28.8)	82 (30.2)	31 (13.2)
2–4 times a month	95 (12.1)	37 (13.2)	33 (12.1)	25 (10.7)
4 or more times a week	40 (5.1)	13 (4.6)	25 (9.2)	2 (0.9)
Monthly or less	168 (21.3)	76 (27.1)	56 (20.6)	36 (15.4)
Never	290 (36.9)	74 (26.3)	76 (27.9)	140 (59.8)
BMI (*n* = 771), *n* (%)				
Underweight	73 (9.5)	12 (4.4)	31 (11.6)	30 (13.1)
Normal	309 (40.1)	130 (47.3)	74 (27.6)	105 (46.1)
Overweight	199 (25.8)	76 (27.6)	54 (20.1)	69 (30.3)
Obesity	190 (24.6)	57 (20.7)	109 (40.7)	24 (10.5)
ARFS category (*n* = 788), *n* (%)				
Needs Work	339 (43)	141 (50.2)	122 (44.7)	76 (32.5)
Getting there	185 (23.5)	62 (22.1)	66 (24.2)	57 (24.4)
Excellent	159 (20.2)	54 (19.2)	45 (16.5)	60 (25.6)
Outstanding	105 (13.3)	24 (8.5)	40 (14.6)	41 (17.5)

Table 2 Unadjusted and adjusted linear regression models showing associations between Australian Recommended Food Score (ARFS) and Preconception Diet Enablers and Barriers Scale (PDEBS)

	Unadjusted Model		Adjusted Model	
	β Coefficients (95% CI)	*p*- Value	β Coefficients (95% CI)	*p*-Value
Healthy diet during the preconception period is important.	**2.66 (−0.03, 5.35)**	**0.052**	**2.21 (−0.64, 5.06)**	**0.128**
Healthy diet during the preconception period is important for healthy pregnancy.	**4.82 (2.33, 7.31)**	**< 0.001**	**4.89 (2.29, 7.48)**	**< 0.001**
Healthy diet during the preconception period is important for healthy baby.	**4.48 (1.94, 7.02)**	**0.001**	**4.12 (1.52, 6.73)**	**0.002**
I believe in the benefits of eating healthy diet during the preconception period for my own general health.	**3.03 (0.38, 5.67)**	**0.025**	**2.57 (−0.23, 5.37)**	**0.072**
I believe in the benefits of eating a healthy diet during the preconception period for any potential babies I have in future.	**2.72 (0.46, 4.98)**	**0.019**	**3.55 (1.17, 5.93)**	**0.004**
I do not have adequate information about eating a healthy diet.	**−1.61 (−3.52, 0.31)**	**0.1**	**−2.21 (−4.18, −0.24)**	**0.028**
I can understand nutritional information available on the Internet/social media related to the preconception period.	**4.31 (2.45, 6.18)**	**< 0.001**	**4.03 (2.09, 5.96)**	**< 0.001**
I can read the nutritional label of food products.	**7.75 (5.48, 10.01)**	**< 0.001**	**7.69 (5.30, 10.08)**	**< 0.001**
I am confident I can start healthy eating whenever needed.	**6.80 (4.86, 8.74)**	**< 0.001**	**6.51 (4.46, 8.57)**	**< 0.001**
I have enough time to prepare healthy foods even though I have other commitments	**4.97 (3.24, 6.70)**	**< 0.001**	**4.82 (3.03, 6.61)**	**< 0.001**
I have enough time to prepare healthy foods even though I have family commitments.	**5.61 (3.87, 7.35)**	**< 0.001**	**5.33 (3.52, 7.15)**	**< 0.001**
I have enough time to prepare healthy foods even though I have job/study.	**4.92 (3.25, 6.59)**	**< 0.001**	**4.64 (2.93, 6.36)**	**< 0.001**
I do not have my family's support to eat healthy foods.	**0.00 (−2.13, 2.12)**	**0.008**	−0.53 (−2.74, 1.68)	0.636
I do not have my friends' support to eat healthy foods.	**−0.93 (−3.20, 1.33)**	**0.419**	−1.64 (−4.02, 0.73)	0.175
I know how to prepare healthy foods.	**6.30 (4.31, 8.30)**	**0**	**5.66 (3.58, 7.75)**	**< 0.001**
I have more access to unhealthy foods.	**−2.45 (−4.07, −0.83)**	**0.003**	**−2.15 (−3.86, −0.44)**	**0.014**
I dislike the taste of healthy foods.	**−3.93 (−5.88, −1.97)**	**< 0.001**	**−4.67 (−6.69, −2.66)**	**< 0.001**
I find healthy foods expensive.	**−3.57 (−5.18, −1.95)**	**< 0.001**	**−3.47 (−5.17, −1.77)**	**< 0.001**
I find lack of variety among healthy foods.	**−3.13 (−4.81, −1.46)**	**< 0.001**	**−3.97 (−5.71, −2.23)**	**< 0.001**
I want to eat a healthy diet to become a healthy person.	**4.35 (2.19, 6.51)**	**< 0.001**	**4.21 (1.95, 6.46)**	**< 0.001**
I want to eat a healthy diet to have a healthy baby.	**4.95 (3.13, 6.78)**	**< 0.001**	**4.26 (2.24, 6.28)**	**< 0.001**
I want to eat a healthy diet to lose weight.	**2.05 (0.28, 3.83)**	**0.024**	**2.28 (0.41, 4.16)**	**0.017**
I want to eat a healthy diet to attract/maintain a partner.	**3.24 (1.63, 4.85)**	**< 0.001**	**2.70 (1.02, 4.38)**	**0.002**
I am eating a healthy diet and will continue to eat a healthy diet.	**6.79 (5.1, 8.49)**	**< 0.001**	**6.40 (4.61, 8.19)**	**< 0.001**
I do not enjoy preparing healthy foods.	**−1.27 (−3.09, 0.55)**	**0.172**	**−1.76 (−3.64, 0.13)**	**0.068**
I am confident that the diet I am currently eating is healthy.	**7.20 (5.62, 8.79)**	**< 0.001**	**6.57 (4.85, 8.29)**	**< 0.001**
I want to be a role model for my children/future children by eating a healthy diet.	**6.58 (4.60, 8.55)**	**< 0.001**	**6.84 (4.73, 8.94)**	**< 0.001**
I am eating healthy to improve body image.	**4.55 (2.79, 6.32)**	**< 0.001**	**3.64 (1.78, 5.50)**	**< 0.001**

(1) β Coefficients based on linear regression (2) Model was adjusted to account for age, marital status, household composition, paid employment, country of residence, educational status, BMI, smoking, drinking, pregnancy planning (4) Disagree is the reference category for each statement. Significant ($p < 0.05$) findings are indicated in boldface

family choices, time restrictions, financial limitations, and access to unhealthy foods.

Integration of quantitative and qualitative findings mapped to the COM-B model

The results from both qualitative and quantitative studies were mapped with the three domains of the COM-B model: capability, opportunity, and motivation. Table 4 presents example quantitative findings and qualitative quotes extracted from both studies, integrated together through the use of a joint display.

Capability

In the capability domain of the COM-B model, knowledge (awareness/lack of importance of a healthy preconception diet) and skills (preparing healthy foods, understanding nutritional labels and nutritional information available on social media/internet) were the constructs identified.

The quantitative findings indicated a high level of awareness among women regarding the importance of a healthy diet during the preconception period. Over 90% of women recognised the significance of a nutritious diet,

Table 3 Demographic characteristics of participants for qualitative study

Demographic Characteristics (*N* = 13)	Value *n* (%)
Age in years	
25–29	2 (15.4)
30–34	3 (23.1)
35–39	2 (15.4)
40–45	6 (46.2)
Ever been pregnant	
Yes	10 (76.9)
No	3 (23.1)
Planned their previous pregnancy	
Yes	9 (69.2)
No	1 (7.7)
Pregnancy plans for future	
No plans/Not sure	8 (61.5)
Currently trying to conceive	2 (15.4)
Considering in future	3 (23.1)

emphasising its importance not only for their own wellbeing but also for a healthy pregnancy and baby. Additionally, 77.1% reported adequate information about maintaining a healthy preconception diet, reflecting a foundation of nutritional knowledge that likely supports effective dietary decision-making. Regression models revealed a positive association between the knowledge of the importance of a healthy diet and favourable outcomes, such as a healthy pregnancy and baby. These quantitative findings were supported by qualitative insights, emphasising the importance of a healthy diet for ensuring the best chances of a healthy life for the baby and mother. Women voiced concerns about ensuring proper nutrition for the baby, highlighting the essential role of a mother's diet in laying the foundation for a healthy life. Personal experiences further emphasised some women's conscious efforts to adopt a nutritious diet before and during pregnancy, illustrating the perceived importance of dietary choices in shaping the wellbeing of both the mother and the unborn child.

Regarding skills related to preconception diet, a substantial percentage of women demonstrated competence in various related aspects. The quantitative survey results indicated high self-reported competence levels, with 80.2% expressing confidence in their ability to prepare healthy foods, 76.2% feeling adept at understanding nutritional information from online sources, and 85.5% asserting proficiency in reading nutritional labels on food products. The corresponding adjusted β coefficients reinforced these findings, indicating positive associations between perceived capabilities and the assessed competencies. However, women in the qualitative study raised concerns about the reliability of information. They had difficulty distinguishing between trustworthy and misleading information of online content and lacking confidence in correctly reading nutritional labels on food products. Women highlighted the need to cross-reference information from multiple sources, seeking guidance from credible sources and healthcare professionals. The qualitative interviews revealed a degree of scepticism toward online influencers and a preference for real-life, professional advice when it comes to making informed decisions about preconception nutrition. In summary, while women exhibited commendable self-reported skills in various aspects of preconception nutrition, the qualitative data shed light on the complexity of navigating the digital landscape and the importance of developing critical appraisal skills in this information-rich era.

Opportunity

In the opportunity domain of the COM-B model, constructs such as social influences (presence of social support, prioritising family choices, time restrictions) and environmental context and resources (financial limitations, access to unhealthy food) were identified.

The quantitative findings revealed that women reported strong support from both family (83%), and friends (85.6%) to assist with maintaining a healthy preconception dietary behaviour. This was complemented by the qualitative findings, emphasising the potential influences of family, friends, and partners on women's behaviours. They highlighted the crucial role of social networks in nurturing a favourable environment for adopting healthier eating habits during the preconception period. On the other hand, qualitative interviews also revealed that accommodating family preferences could pose challenges. Women revealed the necessity to navigate through their children's preferences, sometimes compromising their own dietary goals in the process.

The quantitative survey showed a substantial proportion of women had adequate time to prepare healthy meals, even with other commitments such as family, job, or study. Positive β coefficients associated with these items supported this finding, suggesting a link between perceived time availability and healthy preconception dietary behaviours. Seemingly in contrast, the qualitative study revealed time constraints as a barrier. Women described instances where busy schedules, long working hours, and additional responsibilities, such as walking the dog or arriving home late, made it challenging to prioritise healthy meal preparation.

Financial constraints and accessibility of unhealthy foods emerged as significant factors influencing dietary choices. A majority of women in both the quantitative (53.5%) and qualitative studies expressed concerns about the high cost of nutritious foods along with the rising cost of living. Similarly, the ease of availability of unhealthy foods was reported in both the quantitative (49%) and qualitative studies. Linear regression analysis revealed

Table 4 Joint display of integrated findings from both quantitative and qualitative studies, systematically organised according to the COM-B model

COM-B component	Themed groups of barriers/enablers	Categories of barriers/enablers	Joint display of quantitative and qualitative findings	Integrated summation of findings
Capability	Knowledge	Awareness of importance of preconception diet	The majority of women acknowledged the importance of a healthy preconception diet for their own wellbeing (90.2%), a healthy pregnancy (88.7%), and a healthy baby (88.8%). Agreement with the statement that "Healthy diet during the preconception period is important" was positively associated with higher levels of ARFS score (Table 2). *"…you are what you eat so right so I think it goes to the mother and goes same for the baby. The baby only takes nutrition from the mother. If the mother doesn't eat well, I don't know how can she make sure that baby is healthy…"*	Awareness of the importance of a healthy diet, having skills to cook healthy food, and understanding diet information available via social media acted as enablers for adopting healthy preconception diet. Reliability of information found on social media/internet about preconception diet acted as a barrier.
		Information regarding preconception diet	Many women (77.1% %) expressed adequate information about maintaining a healthy diet during the preconception period. *"I really go through the internet. Like, what is healthy? What is unhealthy? And for everything, like the Internet has been our best gift to be honest. We can find anything, everything over there. And yeah, I do follow the tips over there. What can we eat? What we can't eat? What are the good foods?"*	
	Skills	Preparing healthy foods	The majority of women (80.2%) reported that they knew how to prepare healthy foods. *"I have the skills to cook my own food …. yeah, I think I cook all right and healthy. I include the healthy ingredients so was turned out to be good. Yeah. Excellent based fruit, fresh fruits and vegetables."*	
		Understanding nutritional information available on social media/internet	Over three-quarters (76.2%) of women understood nutritional information from online sources related to the preconception period. *"Like, you know, I, to be honest, I really go through the internet. Like, what is healthy? What is unhealthy? And for everything, like Internet has been our best gift to be honest. We can find anything, everything over there. And yeah, I do follow the tips over there. What can we eat? What we can't eat? What are the good foods?"*	
		Understanding nutritional labels on food products	85.5% of women reported that they can read nutritional labels on food products. *"Yeah, I feel like I do understand the labels for what I'm looking for. So most of the things that I look at is like, amount of sugar and amount of sodium are kind of the most important things for me, as well as like the ingredients list".*	
		Concerns about the reliability of information	*"And I like for example, [name of the organisation] has developed particular wellbeing diets, but I've also heard things like, oh, they were sponsored by the meat association or whatever. So they're encouraging people that eat more meat. So I don't quite know whether to trust that or not. "*	

Table 4 (continued)

COM-B component	Themed groups of barriers/enablers	Categories of barriers/enablers	Joint display of quantitative and qualitative findings	Integrated summation of findings
Opportunity	Social Influences	Presence of social support	The majority of women expressed that they received adequate support from their families (83.0%), and friends (85.6%) for their preconception diet. *"Yeah, my husband is number one champion pushing me… about eating healthy."*	Presence of social support acted as enabler to a healthy diet. Time restrictions, financial constraints and access to unhealthy food has acted as a significant barrier to healthy eating.
		Time Restrictions	68.4% of women reported having enough time to prepare healthy foods despite competing commitments, family responsibilities (70.1%) and work/study obligations (64.9%). *"I think probably just time as well, just I feel that, you know, sometimes I don't get home till maybe 6:30. And then I need to walk the dog and it's dark already. And then by the time it comes to getting dinner, I'm tired, and I just actually can't be bothered."*	
	Environmental context and resources	Financial constraints	Over half of all women (53.5%) expressed they found healthy foods expensive. *"I don't have enough money to buy the things because eating healthy is expensive. Yes. All those vegetables. Now, they are so expensive".*	
		Access to unhealthy foods	Almost half (49.0%) of all participants indicated they have more access to unhealthy foods. *"I mean, we do have food in the house, but like, like a meal that we could cook, but we might just grab, take away. Like we have, literally, sort of 400 m away is a shopping strip, which has quite a lot of like restaurants like Thai restaurant or pizza, pasta, Indian, like different things".*	
Motivation	Beliefs about consequences	Believing in the benefits of a healthy preconception diet	The majority of participants (89.9%) expressed a strong belief in the benefits of a healthy preconception diet for their own general health, with 84.7% agreeing it can have a positive impact on the health of potential future offspring. *"Yeah, as far as like, you know, physical health but mental health as well. I think you know, that it can make a huge difference on your mental health you know, if you just eating rubbish all day, every day, you don't feel good, your mental health is going to decline. So, you know, as you know, the healthier you are the healthier baby".*	Belief in the benefits of a healthy diet, confidence, and positive emotions acted as an enabler. Negative emotions related to the food acted as a barrier.
	Belief about capabilities	Confidence	78.7% of women believed they could initiate healthy eating whenever needed, and 61.0% were confident that their current diet was healthy. The majority of women (73.2%) expressed enjoyment in preparing healthy foods	

Table 4 (continued)

COM-B component	Themed groups of barriers/enablers	Categories of barriers/enablers	Joint display of quantitative and qualitative findings	Integrated summation of findings
	Emotions	Positive emotions related to food	*"…just because I feel better. Physically, I feel better. And happier if I'm eating healthier food."*	
		Negative emotions related to food	*"I don't have a particular interest in cooking, it's not one of my strong points"* *"I don't enjoy cooking anymore. Before I had kids, I might not cook until 11pm. Because it didn't matter. It was just me. And, you know, but now I've got kids, they need to eat by five 530. So, I have to cook by a particular time. And that that pressure of time I don't like and that's why I don't like cooking anymore."* *"Sometimes they don't look very interesting to eat".*	
	Goals	Having goals	The majority of women expressed various motivations for adopting a healthy diet, including personal health (83.8%), promoting the health of their future baby (74.4%), weight management (70.1%), acting as a positive role model for their child or future child (80.0%), improving body image (70.1%), and attracting or maintaining a partner (51.1%). *"The goal is for me to also live healthy… to be free from sicknesses as much as possible… It's not just as much as being a role model to and also, it's for myself. So, the goal is, I think one of the key things too, it's, sometimes I tend to add weight. So, I think I do this also to also check my, my weight, you know".*	

that the convenience of obtaining unhealthy food was associated with making less healthy dietary choices. This aligns with qualitative findings emphasising the convenience of options like takeout and restaurant-prepared meals, particularly in the context of time constraints.

Motivation

Enablers and barriers within the motivation domain of the COM-B model included beliefs about consequences (believing in the benefits of a healthy preconception diet), beliefs about capabilities (confidence), emotions (positive feelings associated with preparing and eating healthy foods), and goals (becoming a healthy person, having a healthy baby, losing weight, maintaining/attracting a partner, aspiring to be a role model for children/future children by eating a healthy diet, improving body image).

Belief in the benefits of a healthy preconception diet acted as a crucial enabler in motivating women for healthy preconception diet. Quantitative findings indicated a strong belief in these benefits, with 89.9%, acknowledging its importance for their overall health, and 84.7% recognising its advantages for future babies. Adjusted β coefficients revealed significant positive associations between these beliefs and adherence to a healthy diet, emphasising their impact on dietary choices during the preconception period. Qualitative insights further supported these findings, with women stressing the importance of a healthy diet when considering future pregnancies. Women viewed it as essential for improving personal health, pregnancy readiness, providing adequate nutrition for babies, and laying the optimal foundation for potential future babies.

Although confidence was not identified as a themed group in the qualitative study, the quantitative results indicated a high level of confidence among women regarding their ability to adopt healthy eating habits during the preconception period. Many (78.7%) expressed confidence in their ability to do so whenever needed. Additionally, approximately two thirds of women (61.0%) exhibited confidence in the healthiness of their current diet. The associated adjusted models revealed strong positive associations between this confidence and the likelihood of adhering to a healthy diet, highlighting the significant impact of confidence levels on the commitment to and maintenance of healthy preconception dietary behaviours.

Emotions such as those related to preparing and eating healthy foods acted as both enablers and barriers to a healthy preconception diet. The quantitative findings revealed that a significant proportion of women (73.2%) agreed with enjoying the preparation of healthy foods. On the other hand, a few women in the qualitative study

expressed a lack of interest in cooking, suggesting potential impacts of these attitudes on preconception dietary decisions. Although not included in the quantitative survey, women in the qualitative study expressed feeling physically and emotionally better when consuming healthier foods. Additionally, they described experiencing guilt when indulging in less healthy options like chips and chocolate, highlighting the psychological aspect of dietary choices. These qualitative insights reinforce the importance of considering both physical and emotional aspects in promoting healthy eating during the preconception period.

In both the quantitative and qualitative study, the desire to achieve specific goals played a critical role as an enabler, empowering women to embrace a healthy preconception diet. A majority expressed their intentions to prioritise healthy eating for personal wellbeing (83.8%), ensure the health of potential babies (74.4%), manage weight (70.1%), attract/maintain a partner (51.1%), and serve as a positive role model for current or future children (80.0%). These aspirations were strongly supported by significant unadjusted and adjusted β coefficients, emphasising the motivational impact of such goals on maintaining a healthy preconception diet. Women in the qualitative study further elaborated on their overarching life goals, encompassing a commitment to lifelong health, freedom from illnesses, and weight management, further encouraging them to adopt healthier dietary habits. Additionally, women consistently described their desire to set a positive example for their children, acting as a potent motivator throughout the preconception journey. The presence of these specific goals emerged as a driving force in encouraging a steadfast commitment to a consistently healthy preconception diet.

Discussion

To our knowledge, this is the first study to investigate enablers and barriers influencing preconception dietary behaviour change in women of reproductive age using a mixed-method approach, in conjunction with the COM-B model. The findings contribute to the current literature by identifying a range of enablers and barriers influencing preconception dietary habits, recognising that certain determinants of behaviour change may lie beyond women's control. Through the integration of quantitative data derived from the online survey regarding the elements of the PDEBS, alongside the detailed insights provided by the qualitative study, we obtained a thorough and contextually rich understanding of the enablers and barriers to preconception diet.

In the capability domain, our findings highlight a high level of awareness among women regarding the crucial importance of a healthy diet before conception, not only for their personal wellbeing but also for ensuring a healthy pregnancy and baby. This aligns with previous research, recognising the essential contribution of knowledge towards shaping positive health behaviours before conception [39]. It is crucial to acknowledge, however, that both our study and the COM-B model acknowledge the complex nature of behaviour change. While knowledge is undeniably important, existing research has also shown that knowledge alone may not invariably translate into behavioural changes [40].

In terms of skills, while the quantitative results highlighted remarkable self-reported skills related to using social media, the qualitative data revealed concerns about the complexity of navigating the digital landscape, emphasising the importance of critical appraisal skills. Women expressed difficulty in distinguishing between trustworthy and misleading online content, emphasising the need for enhanced digital literacy. These findings resonate with prior research, indicating challenges in comprehending numerical data [41] and evaluating nutritional content [42]. While there has been positive acceptability and engagement with the use of preconception digital interventions [43], our study suggests that women need to be empowered with practical skills as well as the ability to critically assess information encountered online. Future interventions and educational programs should consider addressing these intricate challenges to promote a holistic and well-informed approach to preconception dietary choices.

Social support emerged as a key enabler of healthy dietary behaviours, consistent with previous research, emphasising the role of social networks in shaping health-related behaviours and further highlighting the importance of leveraging existing social networks as a resource for promoting positive dietary behaviours among women [44, 45]. Supportive family members, friends, and peers can provide encouragement, motivation, and practical assistance, facilitating adherence to a healthy preconception diet. However, conflicting family preferences, particularly those of children, and time constraints posed significant barriers to maintaining a healthy preconception diet. Household dynamics, including varying dietary preferences among family members, can create challenges in adopting and sustaining dietary changes [46, 47]. Additionally, time pressures resulting from work, caregiving responsibilities, and other commitments may limit women's ability to prioritise meal planning and preparation [48]. These findings highlight the need for interventions that address familial influences and time constraints to support women in making healthier dietary choices during the preconception period. Initiatives such as promoting workplace flexibility and equity to accommodate time constraints, along with offering parenting classes for partners to share caregiving responsibilities, could alleviate some of these challenges and

promote healthy dietary habits among women. Financial constraints and the easy availability of unhealthy foods, often high in calories, sugar, sodium, and unhealthy fats and contributing to poor nutritional outcomes [49], further exacerbate these challenges. Policy interventions aimed at addressing food pricing and availability, such as subsidies for healthy foods and restrictions on the marketing of unhealthy products, could help mitigate financial barriers and promote equitable access to nutritious foods for preconception women [50, 51].

Beliefs in the benefits of a healthy preconception diet, alongside women's confidence in their ability to maintain to healthy eating habits, were identified as enablers, consistent with prior research emphasising the significance of self-efficacy and outcome expectancies in behaviour modification [52]. Recognising the advantages associated with consuming a nutritious preconception diet, such as improved maternal and fetal health outcomes, motivated women to prioritise their dietary choices. Emotional responses to food selection emerged as key determinants, highlighting the necessity to address both affective and cognitive dimensions in dietary interventions. Women's emotional connections to food, including comfort or stress-induced eating patterns, and disliking the taste of healthy foods, significantly influenced their dietary decisions. Strategies targeting emotional regulation and coping strategies may therefore be essential components of comprehensive dietary interventions. The presence of specific goals, such as enhancing maternal and fetal health, managing weight, and serving as a positive role model, were identified as influential motivators, aligning with previous investigations on the efficacy of goal setting and motivation in promoting health behaviour change [53, 54]. Hence, women who establish clear and attainable goals related to their dietary habits are more likely to maintain healthy eating behaviours throughout the preconception period.

While our study provides valuable insights, it is essential to acknowledge several limitations. Firstly, our sequential explanatory approach, while offering depth, may have overlooked less-explored factors. Alternative mixed methods designs, such as sequential exploratory approaches, might have facilitated the identification of additional enablers and barriers, albeit participants were encouraged to talk freely and not be constrained by the barriers and enablers suggested in the semi-structured interviews. Secondly, the piloted PDEBS may have limited response variability and potentially overlooked certain enablers and barriers. However, utilising a mixed-method approach enabled us to capture supplementary factors through qualitative analysis. Furthermore, our qualitative study exclusively focused on interviewing women from Australia due to financial and logistical limitations, potentially limiting the generalisability of our findings to other countries, albeit barriers and enablers were similar across countries. Despite these limitations, the online survey facilitated the inclusion of a large cohort of women, ensuring adequate statistical power for our analyses.

It is also important to acknowledge that participant recruitment relied on online platforms and networks, resulting in a sample that may not be fully representative of the general population of reproductive-aged women in the included countries. Women without internet access, lower digital literacy, or non-English speakers may be underrepresented. Consequently, findings should be interpreted as reflective of women with internet engagement and a potential interest in preconception health.

Overall, this study highlights the multifaceted factors influencing women's preconception dietary behaviours, including factors that influence women's capability, opportunity, and motivation to engage. Interventions should target not only knowledge but also practical skills, emotional regulation, and environmental supports to enable sustainable dietary change. Policymakers and healthcare providers should consider strategies such as improving access to preconception dietary guidance, leveraging family and social networks, and addressing financial and time constraints. These findings provide a foundation for designing tailored, evidence-based programs to improve preconception nutrition and maternal and child health outcomes.

Conclusion

Our study findings, aligned with the COM-B model, indicate the complex array of factors influencing preconception dietary behaviour change, with some of these factors potentially extending beyond the control of women. This emphasises the need for a comprehensive understanding of the multifaceted determinants shaping healthy preconception dietary habits. Enablers identified included an awareness of the importance of a healthy preconception diet, skills to prepare healthy foods, presence of social support, belief in the benefits of healthy preconception diet, confidence in ability to initiate healthy eating whenever needed and healthiness of their current diet, positive feelings associated with preparing and eating healthy foods, and the presence of goals. Future interventions and educational programs should prioritise strategies aimed at enhancing awareness of the importance of preconception dietary habits, fostering the acquisition of relevant skills, and promoting social support networks, targeting not only women but also their social circles. Barriers included concerns about information reliability, negative food-related emotions, prioritisation of family dietary choices, time constraints, financial limitations, and access to unhealthy food. Efforts should be directed towards addressing barriers such as the dissemination of

accurate and accessible information, providing practical solutions for time constraints and financial limitations, and advocating for policies that increase the availability and affordability of healthy food options. Addressing these barriers and enablers will not only facilitate behaviour change but also improve preconception health outcomes for women and their families.

Abbreviations

ARFS	Australian recommended food score
HEQ	Healthy eating quiz
PDEBS	Preconception diet enablers and barriers scale
COM-B	Capability opportunity motivation behaviour
STROBE	Strengthening the reporting of observational studies in epidemiology
SROR	Standards for reporting qualitative research
ORU	Online research unit
BMI	Body mass index
ICR	Inter-coder reliability

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Conceptualisation—P.K. and B.H.; Data curation—P.K. and M.D.; Formal analysis—P.K., B.H. and P.L.; Investigation—P.K. and B.H.; Methodology—P.K., S.L., H.S. and B.H.; Project admin—P.K. and B.H.; Supervision—S.L., H.S., S.C. and B.H.; Writing original draft—P.K.; Writing—review and editing—P.K., S.L., M.D., P.L., H.S., S.C. and B.H. All authors have read and agreed to the published version of the manuscript.

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Data availability

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

Declarations

Ethics approval and consent to participate

This study was approved by the Monash University Human Research Ethics Committee (Project ID: 27935). Informed consent was obtained from all the participants involved in the study.

Consent for publication

All authors have approved the manuscript for publication.

Competing interests

The authors declare no competing interests.

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