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Exploring the determinants of unhealthy dietary behaviors among pregnant women in China using the Theory of Planned Behavior—a cross-sectional study

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Abstract

Background Pregnant women in China are at risk of malnutrition due to an interplay of physiological, psychosocial, and environmental factors. Understanding the factors influencing dietary behaviors in pregnant women is vital for promoting maternal and infant health. This study explores the determinants of dietary behaviors among pregnant women in China based on the Theory of Planned Behavior (TPB).

Methods A cross-sectional survey was conducted with 733 pregnant women recruited from a hospital in Beijing, China, between May 2023 and June 2024. Participants completed a questionnaire to assess dietary patterns and psychosocial factors influencing dietary behaviors. One-way ANOVA analysis was used to test differences among dietary patterns in pregnant women. Multiple logistic regression analysis was conducted to explore the associations between the determinants of the TPB model and dietary behaviors. Decision tree analysis was used to determine cut-off values and assess the importance of determinants affecting dietary behaviors.

Results Factor analysis identified 3 dietary patterns: balanced dietary, unhealthy snacks, and healthy snacks. Multivariate analysis showed that after adjusting for age, education, number of pregnancies, and Pre-pregnancy Body Mass Index (Pre-BMI), pregnant women who report higher environmental scores (OR = 1.55, 95% CI: 1.22–1.97) and lower self-efficacy scores (OR = 1.51, 95% CI: 1.05–2.15) are at an increased risk of adopting unhealthy snack patterns. Conversely, higher positive emotion and self-efficacy scores reduce the risk of adopting unhealthy snacking patterns and make it more likely to adopt a balanced diet pattern(OR = 0.69, 95% CI: 0.55–0.86; OR = 0.56, 95% CI: 0.36–0.89). Finally, we ranked the importance through the decision tree, and the results from high to low were positive emotions, self-efficacy, age, and Pre-BMI.

Conclusions The study suggests interventions focused on enhancing attitudes, self-efficacy, particularly in fat intake management and food label reading, could promote healthier eating behaviors among pregnant women. Future

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research should employ longitudinal designs to confirm these associations and inform effective nutrition strategies tailored to pregnant women in China.

Trial registration This study was preregistered on May 5, 2023, at the Chinese Clinical Trial Registry (ChiCTR2300071126).

Keywords Dietary behaviors, Pregnant women, The Theory of Planned Behavior, Nutrition and diet, Psychosocial determinants, Survey

Background

To support their own health and the development of the fetus, pregnant women undergo various physiological adaptations involving hormones, dermal changes, the gastrointestinal tract, and metabolism. The combined effects of these adaptations, along with dietary changes, shifts in taste preferences, and social psychological factors, significantly increase the craving for highly palatable foods (e.g., sweets, fried foods, fast food) [1]. This craving typically arises in the mid-stage of pregnancy to meet the fetus's developmental needs [2, 3]. Studies indicate that food intake during pregnancy increases by 10–15% compared to pre-pregnancy levels [4]. Additionally, the growing accessibility, affordability, and palatability of these snacks, coupled with prolonged sedentary behavior, contribute to an environment conducive to obesity [5], making pregnant women more susceptible to overeating.

Multiple surveys have shown that pregnant women in rural areas of western China exhibit excessive carbohydrate intake and insufficient fat and protein intake [6]. A study in Hong Kong, China, reported that the median meat consumption among pregnant women exceeds the recommended levels, whereas dairy, fruit, and vegetable intake falls below those recommendations [7]. Another survey conducted in Sichuan, China, revealed that 39% of overall dietary energy among pregnant women comes from fat, which exceeds the recommended amount, while energy from carbohydrates and proteins is below the recommended levels [8]. Misconceptions, such as avoiding beef and mutton, are notably more prevalent in rural areas than urban areas (80% vs. 65.1%) [8]. Poor dietary habits among pregnant women can lead to both overnutrition and malnutrition, increasing the risk of adverse pregnancy outcomes, such as excessive weight gain, difficult deliveries, premature births, and the birth of infants larger for gestational age [9–11]. Therefore, understanding the factors influencing poor dietary behavior in pregnant women and assisting them in achieving a balanced diet is crucial for promoting maternal and infant health and reducing the incidence of adverse pregnancy outcomes [1].

Dietary knowledge, the dietary environment, and attitudes toward the outcomes of dietary behavior are important factors influencing the dietary choices of pregnant women [12]. A review indicated that surveys on the factors affecting pregnant women's dietary behavior typically focus on age, pre-pregnancy body mass index (Pre-BMI), parity, place of residence, psychological depression, and individual health status [13]. Additionally, cultural beliefs play a significant role in shaping pregnant women's diets. Tailored improvement measures should be proposed during intervention processes for pregnant women of different ethnicities and belief systems [14]. A review by Lauren Rockliffe et al. highlighted that the primary factor influencing behavioral changes in pregnant women during pregnancy is self-reflection, particularly regarding the impact of dietary choices on their health and bodily changes. Responsibility for the baby's health, social norms, knowledge, and attitudes also significantly contribute [15]. The factors affecting the dietary behavior of pregnant women are multifaceted, arising from various aspects and dimensions. Therefore, a systematic plan is needed to investigate the main factors influencing the dietary behavior of Chinese pregnant women to provide a scientific basis for future interventions.

The Theory of Planned Behavior (TPB) is a widely utilized framework for examining individuals' intentions to engage in specific behaviors within a given context [16]. It emphasizes enhancing motivation by considering attitudes, perceived norms, and perceived behavioral control in forming behavioral intentions. To comprehensively investigate the factors influencing pregnant women's dietary choices, we extended the TPB to include ethical norms [17], self-perception, emotions [18], skills, and environmental factors that affect actual behavioral control. We developed the Extension TPB (Protocol) to facilitate a deeper understanding of the key factors influencing high-fat dietary behavior among pregnant women.

The aim of this study is to investigate the current dietary status of pregnant women and the related psychosocial determinants. Specifically, we examine how attitudes, perceived norms, and perceived behavioral control relate to the adoption of dietary patterns, and the findings could inform actionable targets for future nutrition interventions.

Methods

Study design

This cross-sectional study collected data using a self-administered online survey. The survey consisted of two

questionnaires: a Food Frequency Questionnaire (FFQ) to assess dietary behaviors and a TPB questionnaire to assess the diet-related psychosocial determinants. This study follows the STROBE-Nut reporting guidelines [19].

Setting and recruitment

Participants

Pregnant women were recruited from a hospital in Beijing, China, between May 2023 and June 2024. Eligible participants were identified during prenatal visits and invited to participate in the study. The inclusion and exclusion criteria are in the research protocol [20].

The sample size should be at least 10 times the number of questions to meet the requirements of factor analysis. In this study, 25 questions were used, and 733 pregnant women were included for factor analysis, which met the analysis requirements.

Instruments and measures

Demographic and characteristics Demographic information, including age, weight, height, education level, and race, was collected through case inquiry.

Food frequency questionnaire A FFQ was used to investigate the dietary habits of pregnant women in the past two weeks. The FFQ was adapted from a previously validated and reliable questionnaire [21, 22], considering the eating habits of Chinese people and the Chinese dietary guidelines for pregnant women. The questionnaire included items on the intake and frequency of different food categories, such as meals (breakfast, lunch, dinner) and snacks consumed between meals. We mainly used dietary intake frequency as the main content of analysis, and divided the frequency of various dietary intake into six categories: from almost never to three times a day or more.

Table 1 Background characteristics

Characteristic	X ± SD/*N*(%)
Age, y	30.95 ± 3.86
Height, cm	162.38 ± 4.91
Weight, kg	58.47 ± 8.89
Pre-BMI, kg/m^2	22.15 ± 3.09
BMI classification[a]	
Underweight(< 18.5 kg/m^2)	66(8.5)
Normal weight(18.5 kg/m^2 ≤ BMI < 24.0 kg/m^2)	588(76.0)
Overweight(24.0 kg/m^2 ≤ BMI < 28.0 kg/m^2)	106(13.7)
Obesity(BMI ≥ 28.0 kg/m^2)	14(1.8)
Race	
Han[b]	581(90.0)
Non-Han	45(10.0)
Education	
Below Junior college	44(7.0)
Junior college and undergraduate programs	434(69.3)
Graduate students and above	148(23.7)
Parity	
Primipara	480(76.7)
Multipara	146(23.3)

[a]According to the standard of recommendation for weight gain during pregnancy period(WS/T 801—2022)

[b]"Han" refers to the majority ethnic group in China

The TPB questionnaire This study investigates the factors that influence maternal diet under the guidance of the extended TPB. The TPB questionnaire was adapted from previously validated tools [23, 24], and its content validity was confirmed by three nutrition experts. The questionnaire was divided into seven scales, each measuring one theory-based determinant: outcome expectations (4 items), positive emotions(3 items), perceived barriers(3 items), social norms (6 items), perceived behavioral control (7 items), behavioral intention (3 items), self-depictions (3 items), environment (4 items), and knowledge (4 items). The determinants were assessed as the mean of items within each scale, measured on 5-point unipolar scales ranging from 1 (strongly disagree) to 5 (strongly agree). The TPB questionnaire, after being adapted and translated into Chinese, underwent a basic reliability and validity test. The results indicated that the overall Cronbach's α coefficient of the questionnaire was 0.933, and the Guttman split-half reliability coefficient was 0.86. After deleting one item, among the 36 items, only 6 items had a Cronbach's α greater than 0.933(Supplement Table 1.). Of these, five items were related to perceived barriers and lack of family support for a healthy lifestyle, which contradicted the overall trend of responses. This suggests that the questionnaire demonstrates high internal consistency. The full TPB questionnaire is provided in the appendix.

Data collection

Participants were directed to the online survey via a QR code provided by the researcher, which was linked to Wenjuanxing.com (a Chinese website for online questionnaires). For the convenience of pregnant women to accurately recall, each type of dietary issue is accompanied by reference pictures of dietary portions. Participants provided online informed consent before completing the questionnaire.

Data analysis

Demographic information was described using mean ± standard deviation for continuous variables and frequency percentage for categorical variables. Demographic factors will be used for the multivariate analysis. Factor analysis was performed to identify different dietary patterns. The frequency of various dietary intakes was categorized based on the factor loadings from factor analysis. Categories were formed by grouping foods with

factor loadings greater than or equal to 0.3 [25]. Each category was named according to the types of foods it contained and the magnitude of the factor loadings. One-way ANOVA analysis was used to test differences among dietary patterns in pregnant women. Multiple logistic regression analysis was conducted to explore the associations between the determinants in the extended TPB model and dietary behaviors. Decision tree analysis was used to determine cut-off values and assess the importance of determinants affecting the dietary behavior of pregnant women. For missing data, the entire individual will be removed in the specific analysis. Data were managed and analyzed using SPSS version 25. The test level $\alpha < 0.05$ was taken as the significant criterion.

Results

Of 784 adults aged 30.95 ± 3.86 years in the survey, 733 had valid FFQ and TPB data. The specific sample size is shown in Fig. 1. Among these individuals, the average Pre-BMI is 22.15 ± 3.09 kg/m^2, with 13.7% being overweight and 1.8% being obese, and 93% of pregnant women have a college degree or above (Table 1). Pre-BMI, education, and obesity rates were examined due to their potential impact on dietary behavior. Prior studies suggest that overweight and obese individuals may have different motivations and barriers to healthy eating [26]. Likewise, education level has been linked to dietary knowledge and behavioral choices [27]. Demographic characteristics were also included in the subsequent decision tree analysis.

Factor analysis and VARIMAX Rotation were conducted. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.744 and Bartlett's test of sphericity was significant (χ^2 = 2554.28, $p < 0.001$), indicating that the correlation matrix is significantly different from the identity matrix and that the data are suitable for factor analysis. Three factors were extracted and named as balanced dietary pattern, unhealthy snack pattern, and healthy snack pattern. The naming of dietary clusters follows conventions summarized in a systematic review [28], where each pattern is named after the representative types of foods most commonly consumed under that

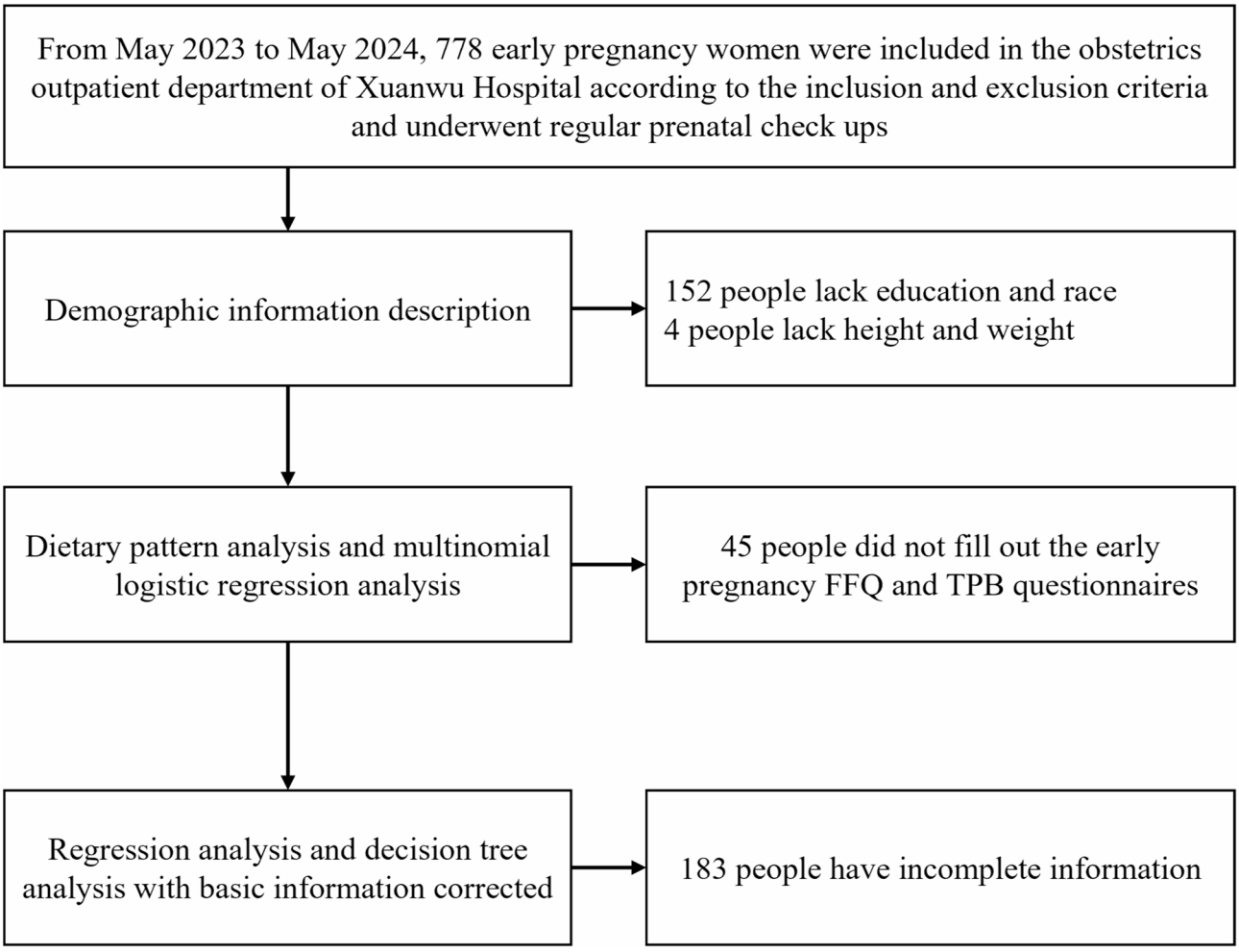

Fig. 1 Basic information flow chart

dietary pattern. The definition of healthy snacks refers to unprocessed or minimally processed foods based on the NOVA definition [29]. Although some factor loadings were below 0.3, they were retained due to their dietary significance in Chinese cuisine. The balanced dietary pattern is likely associated with adherence to healthier food choices (e.g., lean meat, dark green vegetables), while the unhealthy snack pattern suggests an increased intake of high-fat or processed foods. The healthy snack pattern indicates a preference for nutrient-dense snacks like nuts and whole wheat bread. Except the healthy snack pattern, all the factor loadings were greater than 0.3 (Fig. 2).

The analysis of the differences in TPB determinant scores among pregnant women with different dietary patterns showed that, except for "For me, reading food labels makes me feel hard", "If I want to, I could choose foods that are rich in Ω–3 fatty acids" and "If I cook with less oil, the rest of the family will be dissatisfied", all other differences were statistically significant($p < 0.05$). Among the variables with statistically significant differences, the scores for "For me, controlling fat intake makes me feel hard" (P = 0.024), "cooking healthily makes me feel hard" ($P = 0.038$) and "Other family members often want to eat Western-style fast food, or high-fat snacks" ($P = 0.001$) were significantly higher for pregnant women with unhealthy snack pattern compared to other groups, while the scores for other variables were significantly lower for those with unhealthy snack pattern (Supplement Table 2) ($P < 0.05$). To facilitate drawing conclusions, we categorized TPB determinants into positive and negative determinants. Positive determinants refer to psychosocial factors that promote healthy eating behaviors, such as positive emotions and high self-efficacy in controlling fat intake and reading food labels. Negative determinants encompass social influences and perceived barriers that discourage healthy eating, including family preferences for high-fat foods and difficulties in making healthier choices. In summary, Supplement Table 2 revealed that the scores of nearly all TPB determinants differed significantly among participants with varying dietary patterns. Participants following an unhealthy snack pattern had significantly lower scores for positive determinants (positive outcome expectations, positive emotions, positive social norms, self-efficacy, perceived behavioral control, self-depictions, positive behavioral intention, positive environment and knowledge) and higher scores for negative determinants (perceived barriers, negative environment).

A stepwise selection of multivariate logistic regression analysis was conducted to examine the correlation between dietary behaviors and extended TPB determinants. In this study, the Nagelkerke R^2 was 0.122, and after five sequential model iterations, the optimal solution was identified. The complete model fitting procedure is presented in Supplementary Table 3. The final model's −2 log-likelihood was 1004.21, $p < 0.001$ and the likelihood ratio test yielded a chi-square value of 64.00 with 20 degrees of freedom, and a significance level of $p < 0.001$, indicating that the final model is statistically significantly better than the null model. These results suggest that the model can effectively reflect the association between key factors and dietary behaviors of pregnant women to some extent. Figure 3 shows that after adjusting for age, education, number of pregnancies, and pre-pregnancy BMI, pregnant women who report higher "Other family members often want to eat Western-style fast food, or high-fat snacks" (environmental) scores and lower "If I want to, I can read food labels and obtain useful information from them" (self-efficacy) scores are at an increased risk of adopting unhealthy snack patterns and a lower likelihood of adopting healthy snack patterns (OR = 1.55, 95% CI: 1.22–1.97; OR = 1.51, 95% CI: 1.05–2.15). Conversely,

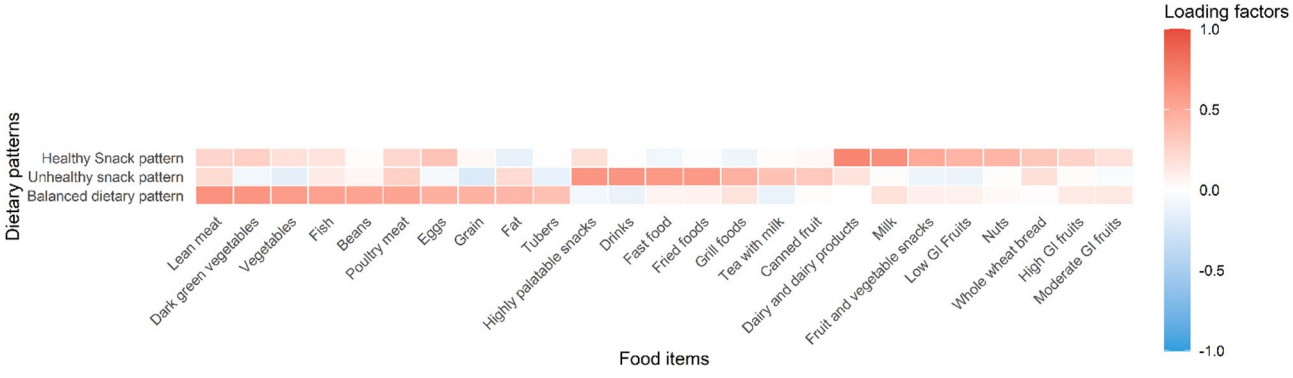

Fig. 2 Dietary patterns analyzed through factor analysis[ab]. **a** Extraction Method: principal component; Rotation: VARIMAX. **b** Although the loading factors for both types of fruits were below 0.3 (not meeting the statistical threshold for categorical consistency), medium-GI fruits and high-GI fruits were retained in the questionnaire as they both belong to the broader fruit category and were grouped with low-GI fruits - a classification that aligns with practical dietary categorization. Moreover, compared to deleting these two items, retaining them only reduced the KMO value by 0.02 and the model's cumulative variance explanation rate by merely 2.2%. So these two items were retained to maintain the completeness of the investigation. In subsequent research phases, we will expand the sample size for further validation and adjustment of these groupings. GI: glycemic index

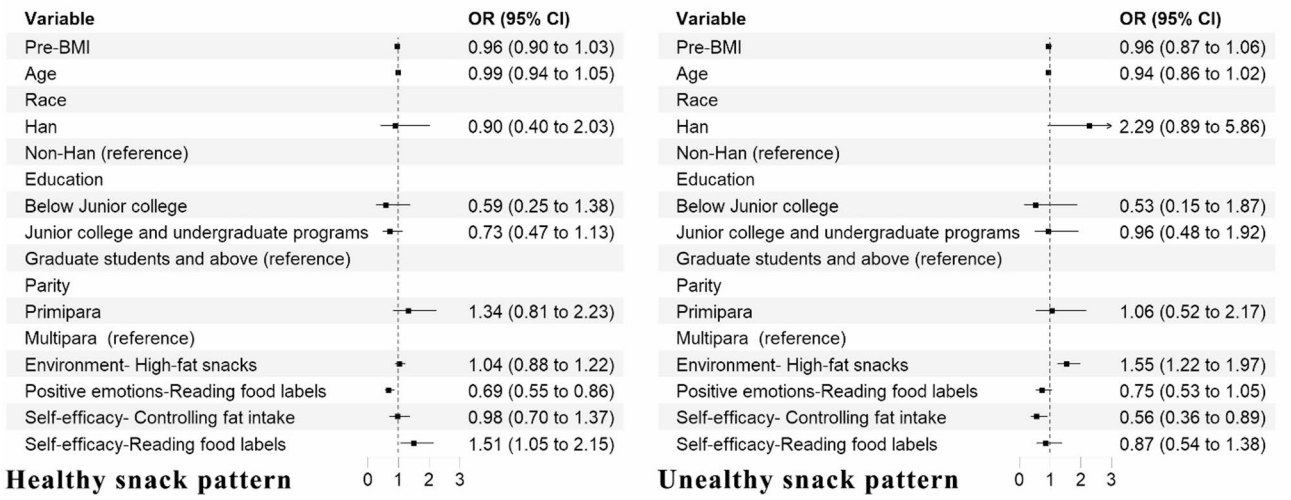

Fig. 3 Multinomial logistic regression analysis between dietary patterns and TPB determinants related to diet after correcting the demographic variables
[a]Reference: Balanced dietary pattern

higher "reading nutrition labels makes me feel happy" (positive emotion) and "If I want to, I can control my fat intake" (self-efficacy) scores reduce the risk of adopting unhealthy snacking patterns and make it more likely to adopt a balanced diet pattern(OR = 0.69, 95% CI: 0.55–0.86; OR = 0.56, 95% CI: 0.36–0.89) (Fig. 3). These findings highlight that TPB constructs, particularly positive emotions, self-efficacy, and environmental influences, play a significant role in shaping pregnant women's dietary patterns.

The variables selected from the regression equation were input into the decision tree analysis, revealing that the prediction accuracy for the test set was 63.3%, while the validation set accuracy was 67.1%. The results indicate that pregnant women who hold a positive attitude and are willing to read food labels are more likely (≥ 4 points) to choose a balanced dietary pattern. This factor is the primary determinant of dietary behavior among pregnant women. Furthermore, pregnant women aged 30 and above with a pre-pregnancy BMI of ≥ 20 kg/m² are more likely to select a balanced dietary pattern. In contrast, pregnant women under the age of 30 with a pre-pregnancy BMI below 24 are more inclined to choose a healthy snack pattern. Pregnant women who show low enthusiasm for reading food labels and self-efficacy scores below 4, coupled with a BMI of ≥ 25, are more likely to select a unhealthy snack pattern, with this proportion reaching 58% (Fig. 4).

Discussion

Utilizing the framework of the extended TPB, this study suggests that several key factors may influence the dietary behaviors of pregnant women. The findings indicate that those with elevated positive factor scores tend to adopt a balanced diet and healthy snacking habits, whereas those with high negative factor scores are more likely to prefer unhealthy snack choices. Multivariate analysis revealed significant associations between attitudes (e.g., toward food label reading), perceived behavioral control (e.g., self-efficacy in controlling fat intake), environmental factors (e.g., family preferences for fast food), and maternal dietary behaviors. Furthermore, pregnant women under 30 may be more inclined to consume snacks; however, those confident in controlling fat intake appear more likely to select healthier options. These results suggest that enhancing pregnant women's motivation to regulate dietary fat, improving their surrounding social environment, and supporting young women in bolstering their self-efficacy in managing fat intake may help promote healthier dietary behaviors.

The main observed behavior in this study is dietary fat intake. Therefore, the main determining factors affecting behavior are also focused on the pregnant woman's ability to control and reduce fat, the surrounding environment for controlling and reducing fat, and knowledge mastery. The results showed that pregnant women with different dietary patterns reported different scores for the degree of identification with various influencing factors. The regression analysis revealed that pregnant women who report higher environmental scores (OR = 1.55, 95% CI: 1.22–1.97) and lower self-efficacy scores (OR = 1.51, 95% CI: 1.05–2.15) are at an increased risk of adopting unhealthy snack patterns and a lower likelihood of adopting healthy snack patterns. Conversely, higher positive emotion and self-efficacy scores reduce the risk of adopting unhealthy snacking patterns and make it more likely to adopt a balanced diet pattern(OR = 0.69, 95% CI: 0.55–0.86; OR = 0.56, 95% CI: 0.36–0.89). These findings underscore the importance of addressing individual attitudes, self-efficacy, and envrionment in promoting healthy

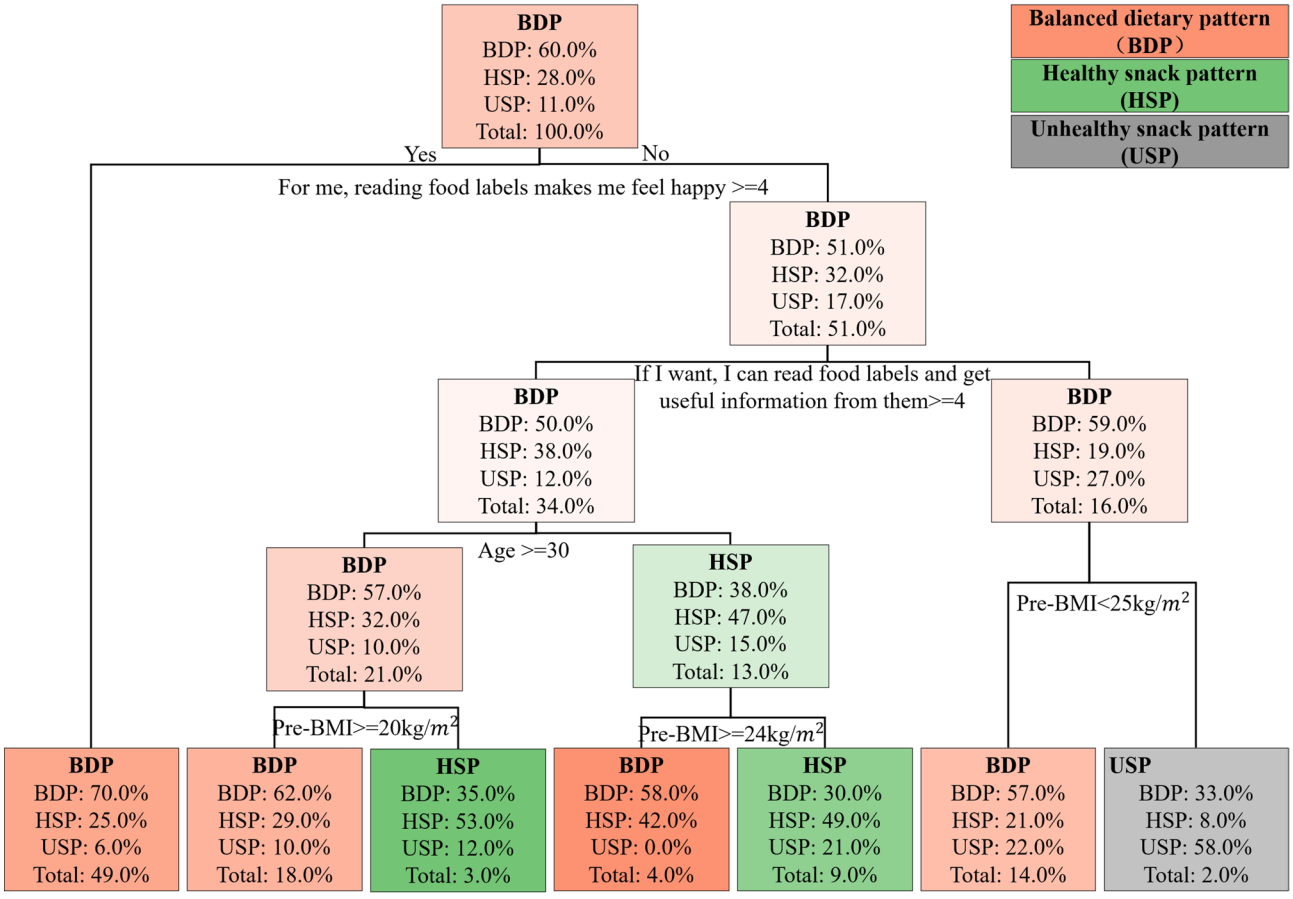

Fig. 4 Decision tree analysis of factors influencing pregnant women's dietary behavior

dietary patterns among Chinese pregnant women. A study among postmenopausal women with osteoporosis in Iran similarly found that subjective norms significantly predicted weight control behaviors across various dietary patterns, highlighting the strong influence of social pressures on dietary choices [30]. Another study focused on women's nutritional behaviors related to cardiovascular disease found that attitude, subjective norms, and perceived behavioral control were all predictors of dietary behaviors, further supporting the utility of TPB in predicting nutrition-related behaviors [31].

A meta-analysis based on TPB showed that key TPB factors—attitudes, subjective norms, and perceived behavioral control—were significantly associated with behavioral intentions, which in turn strongly predicted actual dietary behaviors ($P<0.001$) [32]. The concept of perceived behavioral control consists of two parts: self-efficacy (primarily dealing with the difficulty of executing behavior) and controllability (the degree of performance depends on the actor) [33]. The regression analysis of this study identified 1 environment factors, 2 self-efficacy factor, 1 behavioral attitude factor. The decision tree was truncated and used to rank the importance of the selected factors. The results indicated that a positive attitude toward reading food labels was the primary determinant for adopting a balanced diet. This aligns with some previous findings where attitudes were the strongest predictor of behavioral intentions, though other studies have identified subjective norms and self-efficacy as more significant predictors of dietary behaviors [34]. This discrepancy may be due to differences in the study populations or the specific dietary behaviors being targeted.

Additionally, demographic factors were found to influence dietary patterns. Although the factors of age and pre-BMI were not significant in the logistic regression analysis, they had a significant impact on dietary behavior choices in the decision tree analysis. This difference is due to the distinct modeling approaches used in the two analyses. Logistic regression primarily assesses the independent effects of each variable through regression coefficients and confidence intervals, whereas decision tree analysis predicts dietary patterns by classifying and branching variables [35]. Pregnant women aged 30 or older and those with a pre-BMI of 20 or greater were more likely to follow a balanced diet, while younger women with a lower BMI were more inclined to adopt snack-based diets. This may be due to the interaction between age and barrier factors, which leads to more

obstacles for young pregnant women to choose healthy eating patterns [36]. This suggests that both psychosocial and demographic factors contribute to dietary behaviors, with advanced maternal age and those at higher risk for pregnancy complications potentially being more motivated to adhere to healthier eating patterns.

A major strength of this study is its large sample size and the use of validated tools to comprehensively assess dietary behaviors and psychosocial determinants. Furthermore, this is the first study to examine the associations between TPB determinants and dietary patterns among pregnant women in China. However, the cross-sectional design limits the ability to establish causal associations between TPB constructs and dietary patterns. Additionally, reliance on self-reported data introduces the possibility of recall bias, and the use of dietary FFQ instead of weighing food record in the dietary survey has limitations in extrapolating the results. Due to data limitations, we were unable to obtain additional demographic information on pregnant women, such as income, job responsibilities, and specific dietary energy intake, which are necessary to adjust for potential confounding factors influencing their behavior. This is also an important reason why the accuracy of our prediction model is not very ideal.

Conclusion

This study contributes to the growing body of literature on the psychosocial determinants of dietary behaviors during pregnancy. The results support the use of TPB in predicting dietary behaviors among pregnant women in China. Our study confirms that key TPB constructs—such as attitudes (toward food label reading), perceived behavioral control (self-efficacy in controlling fat intake), and environment (family preferences for fast food)—were strongly associated with dietary patterns in pregnant women. By identifying these key factors, our findings offer valuable insights for developing targeted nutrition interventions aimed at promoting healthier eating patterns among pregnant women. Future interventions should focus on enhancing positive attitudes, environment, and self-efficacy, particularly in areas such as fat intake control, food label reading, and healthy cooking practices. Addressing family influences, especially in reducing high-fat snack consumption, could also improve dietary outcomes.

Abbreviations

TPB	Theory of Planned Behavior
FFQ	Food Frequency Questionnaire
Pre-BMI	Pre-pregnancy Body Mass Index
GI	Glycemic Index
KMO	Kaiser-Meyer-Olkin

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-24357-w.

Supplementary Material 1

Supplementary Material 2

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Author contributions

Huanling Yu and Pamela Ann Koch proposed and designed a research plan, and revised and guided the initial draft of the article. Yadi Zhang analyzed the data and co-wrote the first draft of the article with Xiaoge Gao. Xiaxia Cai and Min Gao are responsible for coordinating the site. Jianying Yue and Yang Sun collecting survey questionnaires. Shengzhi Sun provided guidance and revisions to this research protocol.

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Data availability

The data can be obtained by contacting the corresponding author via email, email: yuhlzjl@ccmu.edu.cn.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (as revised in 2013). The study received approval from Capital Medical University's Ethics Committee (approval numbers Z2022SY077, Z2023SY137). All participants began the survey after reviewing the electronic informed consent form and providing confirmation of their consent following an oral explanation.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Haddad-Tóvolli R, Claret M. Metabolic and feeding adjustments during pregnancy. Nat Rev Endocrinol. 2023;19(10):564–80.
2. Orloff NC, Hormes JM. Pickles and ice cream! Food cravings in pregnancy: hypotheses, preliminary evidence, and directions for future research. Front Psychol. 2014;5: 1076.
3. Bayley TM, Dye L, Jones S, DeBono M, Hill AJ. Food cravings and aversions during pregnancy: relationships with nausea and vomiting. Appetite. 2002;38(1):45–51.
4. Wade GN, Schneider JE. Metabolic fuels and reproduction in female mammals. Neurosci Biobehav Rev. 1992;16(2):235–72.
5. Jensen JD, Bere E, De Bourdeaudhuij I, Jan N, Maes L, Manios Y, Martens MK, Molnar D, Moreno LA, Singh AS, et al. Micro-level economic factors and incentives in children's energy balance related behaviours - findings from the ENERGY European cross-section questionnaire survey. Int J Behav Nutr Phys Act. 2012;9:136.
6. Cheng Y, Dibley MJ, Zhang X, Zeng L, Yan H. Assessment of dietary intake among pregnant women in a rural area of Western China. BMC Public Health. 2009;9:222.
7. Wong HO, Fung H, Rogers MS. Dietary patterns amongst ethnic Chinese pregnant women in Hong Kong. J Obstet Gynaecol Res. 1997;23(1):91–6.
8. Gao H, Stiller CK, Scherbaum V, Biesalski HK, Wang Q, Hormann E, Bellows AC. Dietary intake and food habits of pregnant women residing in urban and rural areas of Deyang city, Sichuan province, China. Nutrients. 2013;5(8):2933–54.
9. Gluckman PD, Hanson MA, Cooper C, Thornburg KL. Effect of in utero and early-life conditions on adult health and disease. N Engl J Med. 2008;359(1):61–73.
10. Langley-Evans SC, Pearce J, Ellis S. Overweight, obesity and excessive weight gain in pregnancy as risk factors for adverse pregnancy outcomes: a narrative review. J Hum Nutr Diet. 2022;35(2):250–64.
11. Mate A, Reyes-Goya C, Santana-Garrido Á, Vázquez CM. Lifestyle, maternal nutrition and healthy pregnancy. Curr Vasc Pharmacol. 2021;19(2):132–40.
12. Kandel P, Lim S, Pirotta S, Skouteris H, Moran LJ, Hill B. Enablers and barriers to women's lifestyle behavior change during the preconception period: a systematic review. Obes Rev. 2021;22(7): e13235.
13. Doyle IM, Borrmann B, Grosser A, Razum O, Spallek J. Determinants of dietary patterns and diet quality during pregnancy: a systematic review with narrative synthesis. Public Health Nutr. 2017;20(6):1009–28.
14. de Diego-Cordero R, Rivilla-Garcia E, Diaz-Jimenez D, Lucchetti G, Badanta B. The role of cultural beliefs on eating patterns and food practices among pregnant women: a systematic review. Nutr Rev. 2021;79(9):945–63.
15. Rockliffe L, Peters S, Heazell AEP, Smith DM. Factors influencing health behaviour change during pregnancy: a systematic review and meta-synthesis. Health Psychol Rev. 2021;15(4):613–32.
16. Fishbein M. I. A: Belief, attitude, intention and behaviour: An introduction to theory and research; 1975.
17. Arbit N, Ruby MB, Sproesser G, Renner B, Schupp H, Rozin P. Spheres of moral concern, moral engagement, and food choice in the USA and Germany. Food Qual Prefer. 2017;62:38–45.
18. Russell PS, Smith DM, Birtel MD, Hart KH, Golding SE. The role of emotions and injunctive norms in breastfeeding: a systematic review and meta-analysis. Health Psychol Rev. 2022;16(2):257–79.
19. Lachat C, Hawwash D, Ocké MC, Berg C, Forsum E, Hörnell A, Larsson CL, Sonestedt E, Wirfält E, Åkesson A, et al. Strengthening the reporting of observational studies in epidemiology - nutritional epidemiology (STROBE-nut): an extension of the STROBE statement. Nutr Bull. 2016;41(3):240–51.
20. Zhang Y, Gao X, Zhu H, Sun S, Contento IR, Koch PA, Yu H. Lipid-focused dietary education intervention in pregnant women: study protocol for an open-label, parallel, randomised, intervention study addressing adverse pregnancy outcomes in China. BMJ Open. 2024;14(1):e076911.
21. Nielsen DE, Boucher BA, Da Costa LA, Jenkins DJA, El-Sohemy A. Reproducibility and validity of the Toronto-modified Harvard food frequency questionnaire in a multi-ethnic sample of young adults. Eur J Clin Nutr. 2023;77(2):246–54.
22. Gray HL, Koch PA, Contento IR, Bandelli LN, Ang IYH, Di Noia J. Validity and reliability of behavior and Theory-Based psychosocial determinants measures, using audience response system technology in urban Upper-Elementary schoolchildren. J Nutr Educ Behav. 2016;48(7):437–e452431.
23. Gratton L, Povey R, Clark-Carter D. Promoting children's fruit and vegetable consumption: interventions using the theory of planned behaviour as a framework. Br J Health Psychol. 2007;12(Pt 4):639–50.
24. Shi H, Wang J, Huang R, Zhao J, Zhang Y, Jiang N, Tanimoto T, Ozaki A, Shao C, Wang J, et al. Application of the extended theory of planned behavior to understand Chinese students' intention to improve their oral health behaviors: a cross-sectional study. BMC Public Health. 2021;21(1):2303.
25. Raniti MB, Waloszek JM, Schwartz O, Allen NB, Trinder J. Factor structure and psychometric properties of the Pittsburgh sleep quality index in community-based adolescents. Sleep 2018;41(6). https://doi.org/10.1093/sleep/zsy066.
26. Abolhassani S, Irani MD, Sarrafzadegan N, Rabiei K, Shahrokhi S, Pourmoghaddas Z, Mohammadifard N, Roohafza H, Asgary S, Moattar F. Barriers and facilitators of weight management in overweight and obese people: qualitative findings of TABASSOM project. Iran J Nurs Midwifery Res. 2012;17(3):205–10.
27. Popiolek-Kalisz J, Cakici C, Szczygiel K, Przytula A. The impact of education level on individual lifestyle behaviors among dietetics students and professionals. Clocks Sleep. 2024;6(1):85–96.
28. de Menezes LRD, RCV ES, Cardoso PC, Dos Santos LC. Factors associated with dietary patterns of schoolchildren: A systematic review. Nutrients 2023;15(11):2450.
29. Dai S, Wellens J, Yang N, Li D, Wang J, Wang L, Yuan S, He Y, Song P, Munger R, et al. Ultra-processed foods and human health: an umbrella review and updated meta-analyses of observational evidence. Clin Nutr. 2024;43(6):1386–94.
30. Hajizadeh H, Sefidmooye Azar P, Nadrian H, Soltani Bejestani F, Kolahi S, Gupta K. Cognitive determinants of weight control by dietary patterns among postmenopausal women with osteoporosis: an application of theory of planned behavior. Health Promot Perspect. 2021;11(4):452–9.
31. Khani Jeihooni A, Jormand H, Saadat N, Hatami M, Abdul Manaf R, Afzali Harsini P. The application of the theory of planned behavior to nutritional behaviors related to cardiovascular disease among the women. BMC Cardiovasc Disord. 2021;21(1):589.
32. McDermott MS, Oliver M, Simnadis T, Beck EJ, Coltman T, Iverson D, Caputi P, Sharma R. The theory of planned behaviour and dietary patterns: a systematic review and meta-analysis. Prev Med. 2015;81:150–6.
33. Ajzen I. Perceived behavioral control, Self-Efficacy, locus of control, and the theory of planned behavior. J Appl Soc Psychol. 2002;32(4):665–83.
34. Malek L, Umberger WJ, Makrides M, Shao Jia Z. Predicting healthy eating intention and adherence to dietary recommendations during pregnancy in Australia using the theory of planned behaviour. Appetite. 2017;116:431–41.
35. Bender R. Introduction to the use of regression models in epidemiology. Methods Mol Biol. 2009;471:179–95.
36. Richards Adams IK, Figueroa W, Hatsu I, Odei JB, Sotos-Prieto M, Leson S, Huling J, Joseph JJ. An examination of demographic and psychosocial factors, barriers to healthy eating, and diet quality among African American adults. Nutrients. 2019;11(3):519. https://doi.org/10.3390/nu11030519

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