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Translation, cultural adaptation, and validation of the maternal health promotion behavior scale

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Abstract

Background United Nations reports show that maternal health is currently deteriorating in most parts of the world, which is far from achieving the 2030 goal of ensuring good maternal health. Adopting health-promoting behaviors during pregnancy is a safe strategy for maintaining and improving maternal and child health. Owing to the high-dimensional, multivariate, and non-directly measurable characteristics of health-promoting behaviors, a comprehensive assessment of these behaviors will help improve population health. The purpose of this study was to translate and cross-culturally adapt Maternal Health Promotion Behavior Scale, which was specifically developed for the maternal population, and to assess the psychometric properties of its Chinese version.

Method This cross-sectional study was conducted between May 2023 and August 2024; convenience sampling was used to select pregnant women in late pregnancy who underwent antenatal checkups. First, the original Maternal Health Promotion Behavior Scale was translated into Chinese and culturally adapted. The psychometric properties of the Chinese version of the Scale were subsequently assessed, including item analysis, content validity, construct validity, internal consistency reliability, and test-retest reliability.

Results A total of 296 pregnant women were included. The Chinese version of the Maternal Health Promotion Behavior Scale consists of 36 scored items in 6 dimensions, with item-level Content Validity Index ranging from 0.83 to 1, and the mean scale-level Content Validity Index of all the items is 0.95. Exploratory factor analysis identified 6 potential factors, and confirmatory factor analysis demonstrated a good fit of the data for this structural equation model. The total Cronbach's α coefficient for the scale was 0.837, McDonald's ω coefficient was 0.848, and test-retest reliability was 0.990.

Conclusion The Chinese version of the Maternal Health Promotion Behavior Scale is a valid and reliable instrument for measuring maternal health-promoting behaviors.

Keywords Maternal, Health promotion, Lifestyle, Psychometric properties

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Introduction

Maternal health is the cornerstone of the health of the next generation, and improving maternal and child health is a crucial factor in promoting population health. Currently, the field of maternal and child health faces a series of challenges, such as mothers' safety (including postpartum hemorrhage and indirect obstetric causes of death), maternal depression, anxiety, stillbirth, preterm birth, birth defects and other related issues [1]. Since 2016, the World Health Organization has issued an early warning that maternal health has deteriorated in most parts of the world [2]. In China, according to the "2023 China Health Statistics Yearbook", the maternal mortality rate in 2022 was 15.7 per 100,000. Postpartum hemorrhage, pregnancy - induced hypertension, and heart disease remain the main causes of death. The neonatal mortality rate was 3.1‰, the infant mortality rate was 4.9‰, the incidence of low birth weight was 3.97%, and the prevalence of low body weight in children under 5 years old was 1.21%. The maternal and child health status in urban areas is better than that in rural areas [3]. Adopting a health-promoting lifestyle during pregnancy is a safe strategy to maintain and improve maternal and child health [4]. When women are pregnant, they tend to be more concerned about their health and have a strong motivation to change their behavior [5]. They are willing to adopt a healthy lifestyle to promote maternal and infant health. Tarrant et al.'s study also revealed that the desire for a better pregnancy and a healthy baby were the main motivators for women's behavioral change [6]. Thus, pregnancy is a critical window of opportunity for effective improvement in women's health-promoting behaviors.

Promoting healthy behaviors among pregnant women can not only alleviate depression, anxiety and other negative emotions [7, 8] and reduce the incidence of obesity, hypertension, diabetes [9, 10] and other complications among pregnant women.Additionally, it can reduce fetal stunting, birth defects, and chronic health risks for mothers and babies, Such as maternal chronic hypertension and diabetes in later life, and offspring obesity and hypertension in adulthood [11, 12], thus improving the health of mothers and their offspring at the lowest possible cost. Currently, the overall health-promoting behaviors of pregnant women are good but need to be further improved [13].

Professor Pender [14] put forward the health promotion model (HPM) in 1982 to offer a theoretical framework for comprehending and enhancing health-related behaviors, highlighting that both previous relevant behaviors and personal factors have a direct influence on an individual's health-promoting behaviors. The model categorizes healthy lifestyle behaviors into health-protective behaviors and health-promoting behaviors. Health-promoting behaviors (HPBs) are multidimensional and persistent, initiated by individuals themselves and based on positive convergent behaviors [15]. The World Health Organization (WHO) has given top priority to health promotion on the global health agenda and is vigorously promoting the extensive utilization of health-promoting behaviors in various populations and disease management strategies [16].

Due to the high-dimensional, multivariate, and non-directly measurable characteristics of health-promoting behaviors, accurate assessment of these behaviors is essential for improving population health. In 1987, Walker, Sechrist, and Pender [17] developed a valid and reliable health-promoting lifestyle measurement tool (Health-Promoting Lifestyle Profile I, HPLP I) based on the HPM model, which was revised to form the HPLP-II in 1995 [18]. In 2016, Wenjun Cao [19] translated the HPLP-II scale into a Chinese version and measured the reliability and validity of the scale in a mainland Chinese population. The Health Promotion Lifestyle Scale has good reliability and validity in different cultures and is widely used to assess the level of health promotion behaviors in different populations, such as adolescents, women, and elderly individuals. However, as a universal health promotion behavioral scale, the content of the entries cannot cover the characteristics of different populations and specialty diseases, and for specific populations such as pregnant women, its applicability and cultural adaptability still need to be further researched and explored. Moreover, existing studies have overly focused on structured exercise (such as regular prenatal yoga and jogging), ignoring unstructured exercise (such as housework, occupational activities, and walking to commute). This underestimates the actual activity level of pregnant women in China and leads to biases in the assessment of health behaviors.

Lifestyle is the practice of people taking the initiative to maintain and promote their health and has become the primary factor affecting human health, and women's lifestyle before and during pregnancy can positively or negatively affect the health of the mother and child [11]. Li Y and Yang Z et al. defined a healthy lifestyle as not smoking, not consuming alcohol, maintaining a healthy body weight, getting enough sleep, engaging in regular moderate or strenuous physical activity (≥ 1 h per day) and a healthy diet [20]. The impacts of diet, alcohol consumption, physical activity and smoking [21–24] status, which are important lifestyle factors for maternal and fetal health, have been studied and confirmed in several studies. From a prevention perspective, achieving these healthy lifestyles, especially when measured as overall health behaviors, better promotes maternal health [25].

Although current research has revealed associations between lifestyle and certain diseases, most studies address only a single aspect of promoting a healthy

lifestyle, mainly physical activity and nutritional intake [26]. Hungarian scholar Evelin Polanek [25] assessed the four important lifestyle factors of diet, physical activity, smoking and alcohol consumption as a whole and developed Maternal Health Promotion Behavior Scale (MHPB), whose main goal is to promote the adherence of pregnant women to a healthy lifestyle, rather than to measure health risks. The scale consists of 11 items in 4 dimensions, including dietary habits (7 items, total score = 12), physical activity (2 items, total score = 2), smoking during pregnancy (1 item, total score = 3), and alcohol consumption during pregnancy (1 item, total score = 3), with total scores ranging from 0 to 20, with higher scores indicating healthier lifestyles. The items of the scale are consistent with pregnancy-related health behaviors, thus improving the understanding ability of testers and the stability of results. In addition, it includes contraindicated behaviors during pregnancy. Compared with the HPLP scale and maternal mental health scales, it more precisely focuses on changeable proactive health behaviors, providing stronger utility for targeted interventions.

Currently, the MHPB scale has not been cross-culturally adapted in other languages or cultures. In this study, the MHPB scale was translated into Chinese and culturally adapted to test its reliability and validity in China's maternal population, thus enriching the research tools for assessing the level of maternal health promotion. The Chinese version of the MHPB scale adds an assessment of sleep during pregnancy and pays attention to the physical exertion of pregnant women caused by daily activities, housework, and occupational exercise, thus, it can more accurately assess the health-promoting behaviors of pregnant women, providing a scientific basis for the government and healthcare institutions to develop and implement policies or measures to promote the health-promoting behaviors of pregnant women.

Method

Study design and participants

This cross-sectional study was conducted from May 2023 to August 2024. The convenience sampling method was used to select singleton pregnant women who visited the hospital for labor and delivery at 34 weeks of gestation or more. Those with acute pregnancy complications and other serious internal and surgical diseases were excluded from the study. The study participants were from a tertiary general hospital in Dongguan, Guangdong Province, China, and a secondary general hospital in Shenzhen, China. According to the recommendations of Watkins [27], the sample size included in the scale validation process should be 5 to 10 times the number of scale items, and it was expected that at least 200 cases would need to be included. The study was approved by the hospital ethics committee (No. 2023–002), which granted permission for data collection. A paper questionnaire was administered face-to-face by the researcher, and the participants agreed to sign an informed consent form. All participants were informed of their right to choose to participate or withdraw from the study at any time, that there would be no adverse effects on their medical treatment and care, and that data confidentiality would be ensured.

Translation and cross-cultural adaptation

Authorization and confirmation of the original English version of the MHPB scale were obtained via e-mail. The MHPB scale was translated into Chinese and culturally adapted according to the WHO guidelines for the translation of instruments [28]. First, two bilingual translators familiar with scale development independently translated the source scale into Chinese and agreed on a version after discussion; then, another bilingual translator majoring in English translation back-translated it into English without reading the source scale. Subsequently, a native English-Speaking monolingual translator familiar with the field of maternal health then compared the source scale with the back-translated version to establish semantic equivalence. Finally, all the translators and a language expert familiar with medical scales agreed on the English back-translated version and then translated it into Chinese. The translators were all graduate students majoring in midwifery. The initial Chinese version of the MHPB scale was reviewed and created by the research team.

Considering the different clinical practices and cultural backgrounds of East China and West China, two obstetricians and gynecologists (with a professional title of associate senior or above and more than 15 years of clinical experience), two clinical nurse specialists (with a professional title of associate senior or above and familiar with obstetric and gynecological nursing practice), and two obstetric and gynecology faculty members (with a professional title of intermediate or above and familiar with the field of maternal health promotion), were invited to form an expert committee to carry out cultural adaptation and test the face validity and content validity. Revisions to the items were made on the basis of expert feedback to make them more relevant to the Chinese context and easier to understand. The test version of the Chinese version of the MHPB scale was finalized when the same group of experts reached sufficient validity after several rounds of discussion.

In accordance with the recommendations of Sousa and Rojjanasrirat [29], a presurvey was conducted via the test version, 30 late-pregnant women were invited to evaluate the content, wording, and semantics of the scale, and the researcher made corrections to the content of the scale on the basis of the feedback and modified the unclear or

doubtful points. After all the above steps were completed, the Chinese version of the MHPB scale was formed for the official survey.

Research tools

Chinese version of the MHPB scale

The scale consists of 40 items in 5 dimensions, including diet during pregnancy (12 items, total score = 48), physical activity during pregnancy (18 items, total score = 72), sleep during pregnancy (8 items, total score = 24), smoking during pregnancy (1 item, total score = 2), and alcohol consumption during pregnancy (1 item, total score = 2). The first three dimensions used a 5–point Likert scale (0–4 points), while the last two dimensions were scored on a 3–point Likert scale (0–2 points). The total scale score ranges from 0 to 148, with higher scores indicating better health-promoting behaviors during pregnancy.

The Chinese version of MHPB scale has three key improvements: (1) A new "sleep during pregnancy" dimension has been added to strengthen the assessment framework of health-promoting behaviors. (2) The physical activity dimension has been expanded from 2 items to 18 items, covering "leisure activities", "occupational activities" and "household activities". (3) One option has been added to both the "smoking" and "alcohol consumption" dimensions to distinguish between pre - pregnancy and pregnancy behavior patterns. At the same time, the total score of a single dimension has been reduced from 3 points to 2 points, reflecting a stricter perception of pregnancy taboos in China.

HPLP-II Chinese Revised Version (HPLP-II R)

The scale is a revised Chinese version of the HPLP-II [19]. The scale consists of 40 items in 6 dimensions, including interpersonal relationships (5 items), health responsibilities (11 items), stress management (5 items), nutrition (6 items), physical activity (8 items), and spiritual growth (5 items). On a 4–point Likert scale, "never" to "always" are assigned scores ranging from 1 to 4, and the total score ranges from 40 to 160, with higher scores indicating healthier lifestyles. A higher score indicates a healthier lifestyle. In this study, the Chinese version of the MHPB scale was used as a reference standard for measuring its validity.

Statistical analysis

The data were analysed via IBM SPSS 25.0 and IBM SPSS Amos 25.0. Descriptive statistical analysis was performed to analyse the health promotion behavior and sociodemographic characteristics of the pregnant women. Count data are presented as frequencies and percentiles. Measurement information, such as data conforming to a normal distribution, was described by the mean and standard deviation, and those not obeying a normal distribution were described by the median and interquartile range. The normality of the data was assessed by kurtosis and skewness (both absolute values less than 3) [30].

Face and content validity

A dichotomous "yes" and "no" scale was administered to six experts, who were asked to evaluate the terminology, grammar, adequacy, appropriateness, and item structure of the scale [31]. The same group of experts assessed the relevance of each item of the scale to its dimension via a 4–point Likert scale, with scores from 1 to 4 representing "not relevant", "weakly relevant", "relevant", and "very relevant", respectively. "very relevant". According to the Lawshe Table [32], the scale-level content validity index (S-CVI) and item-level content validity index (I-CVI) were calculated, and I-CVI ≥ 0.78 and the mean CVI of all the items (S-CVI/Ave) ≥ 0.90 were considered acceptable [33].

Project analysis

The critical ratio (CR) and correlation analysis were used. A CR value > 3 ($P < 0.05$) suggests good discrimination of the entries [34]. Pearson correlation analysis was used to calculate the correlation coefficients between the entries and the total scores of the scales, and items with no statistical significance or $r < 0.30$ were excluded [35].

Structural validity

To test whether the dataset was suitable for factor analysis, Bartlett's sphericity test and the Kaiser–Meyer–Olkin (KMO) test were performed first; if the KMO value was > 0.70 and Bartlett's sphericity test result was < 0.05, it was considered suitable for factor analysis [36]. Factors with > 1 eigenvalue were extracted via principal component analysis (PCA), and the rotated factor loading matrix was derived via the maximum variance method. Entries with factor loading values greater than or equal to 0.3 and common factor variance greater than 0.2 were considered suitable [37], and the cumulative total variance explained should be greater than 40.0% [38] Model fit was evaluated via the following metrics: chi-square/degree of freedom (χ^2/df), root mean square error of approximation (RMSEA), standardized mean square residual (standardized root mean square residual (SRMR), root mean square residua(RMR), comparative fit index (CFI), Tucker–Lewis index (TLI) and incremental fit index (IFI). Acceptable model fit was defined as χ^2/df of 1–3, RMSEA and SRMR < 0.08, RMR < 0.05, and CFI, TLI and IFI > 0.85 [39, 40].

Concurrent validity

The Pearson correlation coefficient was used to measure the degree of correlation between the Chinese version of

the MHPB scale and the HPLP-II R scale, with r values between 0.4 and 0.8 being preferable [41].

Reliability

The reliability of the scale was assessed by internal consistency and retest reliability.

Cronbach's α coefficient, McDonald's ω coefficient and corrected item–total correlation (CITC) were used to assess the internal consistency. An acceptable reliability is indicated when the Cronbach's α coefficient for the total scale is greater than or equal to 0.70 [42, 43], the Cronbach's α coefficient for the dimensions is greater than or equal to 0.60, and the McDonald's ω coefficient is greater than 0.70 [44]. A CITC ≥ 0.30 is considered adequate or better [45].

Stability was assessed via retest reliability and the interclass correlation coefficient (ICC). Thirty pregnant women were reassessed after 2 weeks. A test reliability > 0.70 [46] and an ICC ≥ 0.80 are generally considered acceptable [39].

Results

Social demographics

A total of 315 questionnaires were collected in this study, and 296 questionnaires were valid, with a validity rate of 93.97%. The characteristics of the samples are shown in Table 1. The characteristics of the two subsamples were similar to those of the total sample and also similar to each other. The scores of the Chinese version of the MHPB scale for pregnant women ranged from 41 to 109, with no floor or ceiling effects, and the mean score was 72.62 ± 12.89 (total score was 0–144), which was at an intermediate level. The scores, in descending order, were healthy diet during pregnancy, poor diet during pregnancy, sleep during pregnancy, exercise during pregnancy, household activities during pregnancy, and occupational activities during pregnancy. The scores of the

Table 1 Characteristics of the sample

Variable	Categorization	Overall sample *N* = 296 / n%	Exploratory factor sample *N* = 123 / n%	Confirmatory factor sample *N* = 173 / n%
AGE (YEAR)	< 24	32 (10.81)	13 (10.57)	19 (10.98)
	24–35	222 (75.00)	91 (73.98)	131 (75.72)
	≥ 35	42 (14.19)	19 (15.45)	23 (13.29)
BMI	< 18.5	51 (17.23)	15 (12.2)	36 (20.81)
	18.5–25	204 (68.92)	88 (71.54)	116 (67.05)
	25-29.9	38 (12.84)	18 (14.63)	20 (11.56)
	≥ 30	3(1.01)	2 (1.63)	1 (0.58)
EDUCATIONAL ATTAINMENT	Low	72 (24.33)	21 (17.07)	51 (29.48)
	Medium	87 (29.39)	41 (33.33)	46 (26.59)
	High	137 (46.28)	61 (49.59)	76 (43.93)
NATURE OF WORK	Mental work	168 (56.76)	76 (61.79)	92 (53.18)
	Manual work	27 (9.12)	9 (7.32)	18 (10.4)
	Unemployed	101 (34.12)	38 (30.89)	63 (36.42)
MONTHLY PER CAPITA HOUSEHOLD INCOME (RMB)	< 3000	12 (4.05)	5 (4.07)	7 (4.05)
	3000–6000	144 (48.65)	57 (46.34)	87 (50.29)
	6000–10,000	83 (28.04)	40 (32.52)	43 (24.86)
	>10,000	57 (19.26)	21 (17.07)	36 (20.81)
MEDICAL PAYMENT METHOD	Urban workers' medical insurance	161 (54.39)	73 (59.35)	88 (50.87)
	Urban residents' medical insurance	37 (12.50)	15 (12.2)	22 (12.72)
	Rural Cooperative Medical Insurance	30 (10.14)	13 (10.57)	17 (9.83)
	Self - funded/ Others	68 (22.97)	22 (17.89)	46 (26.59)
DOMICILE	town	176(59.50)	76(61.79)	100(57.8)
	rural area	102(34.46)	41(33.33)	61(35.26)
	rural–urban fringe zone	18(6.08)	6(4.88)	12(6.94)
MAIN EXERCISE HABITS BEFORE PREGNANCY	Very little exercise	62 (20.95)	25 (20.33)	37 (21.39)
	Light exercise	178 (60.13)	74 (60.16)	104 (60.12)
	Low-intensity exercise	43 (14.53)	18 (14.63)	25 (14.45)
	Moderate intensity exercise	7 (2.36)	1 (0.81)	6 (3.47)
	Intensive exercise	6 (2.03)	5 (4.07)	1 (0.58)
MODE OF DELIVERY	Eutocia	209 (70.61)	88 (71.54)	121 (69.94)
	Cesarean section	87 (29.39)	35 (28.46)	52 (30.06)
NEWBORN WEIGHT	< 2.5 kg	7 (2.36)	1 (0.81)	6 (3.47)
	2.5–4.0 kg	279 (94.26)	119 (96.75)	160 (92.49)
	≥ 4.0 kg	10 (3.38)	3 (2.44)	7 (4.05)

HPLP-II R scale ranged from 66 to 160, with a total score range of 0 to 160 and a mean score of 102.21 ± 18.30, indicating a moderate level. The scores in descending order were for nutrition, spiritual growth, interpersonal relationships, stress management, health responsibilities, and physical activity.

The results of one-way analysis of variance showed that age ($F = 5.804$, $P < 0.05$), medical payment method ($F = 4.453$, $P < 0.05$), and pre - pregnancy main exercise habits ($F = 6.897$, $P < 0.001$) had statistically significant differences in the overall score of the MHPB scale. Pregnant women aged 35 years or older, those with medical insurance payment, and those with pre - pregnancy exercise habits had higher scores.

Content validity and face validity

After the first round of consultation with the Expert Committee, the content of the relevant entries was revised on the basis of the content of the source scale entries, with reference to Chinese and international guidelines and scales on maternal diet and exercise. The "diet during pregnancy" dimension refers to the Dietary Guidelines for Chinese Residents (2022) published by the Chinese Nutrition Association, and the number of entries increased from 7 to 12. The "Exercise during pregnancy" dimension refers to the Baecke Physical Activity Scale (1982) and Kaiser Physical Activity Survey (KPAS) and includes 2 to 18 items, which are "Physical activities during pregnancy" (3 items),"leisure activities during pregnancy" (5 items), "occupational activities during pregnancy" (5 items), and "household activities during pregnancy" (5 items). Regarding the item "Watching TV during leisure time", considering that mobile phones, tablets and other electronic devices have replaced "watching TV" to a large extent and the harm of sedentary behavior, it was revised to "Being sedentary during leisure time". Considering that maternal sleep problems are common but often overlooked by pregnant women and prenatal care providers [47], the Pittsburgh Sleep Quality Index (PSQI) was used as a reference to add a dimension of "sleep during pregnancy" (8 items). At the same time, based on the cautious attitude of Chinese families and clinical practice towards the use of sleeping pills during pregnancy, the item "use medication to help you sleep" was deleted. Diet, exercise, and sleep during pregnancy were scored on a five-point Likert scale ranging from 0 to 4. Considering that smoking and alcohol consumption should be quit at least half a year before the pre-pregnancy period, the items of "Smoking during pregnancy" and "Alcohol consumption during pregnancy" were revised. The original scale had two options and scoring methods of "Yes – 3 points" and "No – 0 points". Now, they have been modified to three options and corresponding scoring: "Never smoked (drank) – 2 points", "Smoked (drank) within six months before pregnancy but quit during pregnancy – 1 point", and "Smoked (drank) during pregnancy – 0 points". After several rounds of discussion and entry revisions, the same group of experts finalized the test version of the Chinese version of the MHPB scale and confirmed that the content validity of the scale met the standard (I-CVI ranging from 0.83 to 1.00, S-CVI/Ave = 0.95). In the face validity assessment, all six experts answered "yes" to all the items of the MHPB scale.

A pre-survey was conducted using the test version of the Chinese MHPB scale. 30 questionnaires were distributed and retrieved on - site, with a recovery rate of 100% and an effective rate of 100%. The testers reported that they rarely rode bicycles during pregnancy. Therefore, "Riding a bicycle during leisure time" in "Leisure activities during pregnancy" was revised to "Taking a brisk walk or going up and down stairs during leisure time", and "Time spent walking or cycling every day" was revised to "Time spent walking during commuting and shopping every day". After these revisions were completed and discussed and approved by the expert committee, the formal Chinese MHPB scale for investigation was formed.

Item analysis

Except for the two dimensions of smoking during pregnancy ($CR = 1.35$, $r = 0.141$) and alcohol consumption ($CR = 1.35$, $r = 0.068$), the CRs of each entry of the other dimensions were > 3 (4.70–9.48), and the r values were > 0.3 (0.313–0.544) ($P < 0.001$), which indicated that the entries except for smoking during pregnancy and alcohol consumption had a good discriminatory degree; therefore, the dimensions of smoking during pregnancy and alcohol consumption were deleted.

Structural validity

Exploratory factor analysis (EFA)

EFA was used to identify the underlying factor structure of the 123 samples, the absolute values of skewness and kurtosis of the total MHPB scale score and the scores of each dimension in this subsample ranged from 0.002 to 0.77 and 0.008–1.236, respectively, and the data conformed to a normal distribution. KMO = 0.724, and Bartlett's test of spherical shape was significant ($\chi 2 = 2280.727$, $P < 0.001$), which is suitable for factor analysis. A total of nine public factors were extracted via principal component analysis, but the results of the rotated component matrix revealed that five entries had significant cross-loadings and that three dimensions contained ≤ 2 entries, which was different from the dimensions initially developed. The optimal number of extracted factors was determined by combining the information from the eigenvalues, commonalities, scree plots and parallel analysis [48]. Finally, the 6-factor model

was determined to be optimal on the basis of statistical indicators, theoretical assumptions, and model interpretability. As shown in Table 2, the factor loadings of the 6-factor model are all > 0.3 (0.323–0.905), the cumulative total variance explained rate is 57.165%, and the covariance is > 0.2 (0.211–0.869), which is more consistent with the original set dimensions, and all the entries are retained. According to the content of the entries and their attribution factors, the 8 positive-scoring entries (1.1–1.8) of the original "diet during pregnancy" were reclassified and named "healthy diet during pregnancy", and the 4 reverse-scoring entries (2.1–2.4) were reclassified as "poor diet during pregnancy". The former "physical activity during pregnancy" was categorized into "physical activity during pregnancy", "leisure activity during pregnancy", "occupational activity during pregnancy (4.1–4.5)" and "household activity during pregnancy(5.1–5.5)". The first two were merged into the same dimension and named "Exercise during pregnancy" (3.1–3.8).

Confirmatory factor analysis (CFA)

CFA was conducted on the data of 173 samples according to the six-factor structural model, the absolute values of skewness and kurtosis of the total MHPB scale score and the scores of each dimension in this subsample ranged from 0.065 to 0.598 and 0.114–0.982, respectively, and the data conformed to a normal distribution. The maximum likelihood (MI) method was applied to evaluate

Table 2 Item factor loadings from exploratory factor analysis

Items	Entry	1	2	3	4	5	6
1.1	Frequency of a balanced, reasonable and diversified diet daily	**0.784**	0.062	0.044	0.135	0.1	0.156
1.7	Frequency of having 200 ~ 350 g of fresh fruits daily	**0.746**	0.1	0.202	-0.024	0.138	-0.005
1.4	Frequency of having 300 ~ 500 g of milk and dairy products daily	**0.655**	0.141	0.177	0.306	0.028	-0.159
1.3	Frequency of having cereals as the staple food and including whole grains in each meal	**0.632**	-0.074	0.046	-0.047	0.185	0.12
1.5	Frequency of taking aquatic products at least twice per week and 1 egg daily	**0.612**	0.197	0.211	0.129	0.06	-0.157
1.2	Frequency of having breakfast daily, three regular meals and no midnight snacks	**0.603**	0.103	0.013	0.217	-0.019	0.165
1.6	Frequency of having 300 ~ 500 g fresh vegetables and dark vegetables daily	**0.553**	0.04	0.388	0.038	0.191	0.077
1.8	Frequency of drinking enough water daily and not having sugary, carbonated, caffeinated and alcoholic drinks	**0.553**	-0.116	0.124	0.124	0.127	0.35
4.3	Frequency of walking around at work during pregnancy	0.137	**0.905**	0.086	0.01	-0.141	0.064
4.2	Frequency of standing at work during pregnancy	0.045	**0.87**	0.121	-0.027	-0.065	0.013
4.1	Frequency of sitting at work during pregnancy	-0.036	**0.86**	0.118	-0.02	-0.021	0.022
4.5	Frequency of sweating at work during pregnancy	0.08	**0.816**	0.066	0.048	-0.015	0.201
4.4	Frequency of carrying heavy objects at work during pregnancy	0.146	**0.711**	0.014	-0.156	0.061	0.038
3.2	The time of each above physical activity during pregnancy	0.049	0.032	**0.768**	-0.053	0.027	0.023
3.3	Frequency of doing these physical activities once during pregnancy	0.053	0.066	**0.675**	0.062	0.066	0.202
3.6	Frequency of walking (> 10 min) during pregnancy in leisure time	0.207	0.159	**0.642**	0.176	0.173	0.257
3.8	Walking time during commuting to and from work and shopping during pregnancy daily	-0.043	0.105	**0.632**	0.017	0.088	-0.22
3.1	Intensity of physical activity during pregnancy	0.161	-0.056	**0.6**	0.147	-0.037	0.175
3.5	Frequency of exercise (≥ 15 min) during pregnancy in leisure time	0.327	0.196	**0.559**	0.151	0.197	0.149
3.7	Frequency of brisk walking or walking up and down stairs (> 10 min) during pregnancy in leisure time	0.283	0.004	**0.491**	-0.087	-0.116	-0.018
3.4	Frequency of sitting still during pregnancy in leisure time	0.092	0.082	**0.323**	0.13	0.198	0.189
6.5	Sleep quality in the last 1 month	0.122	-0.012	0.044	**0.831**	-0.049	-0.037
6.2	Situation of falling asleep in the last 1 month	0.071	0.079	0.023	**0.808**	-0.128	-0.043
6.4	Frequency of sleep disorders in the last 1 month	0.025	-0.178	0.025	**0.79**	-0.028	-0.07
6.6	Daytime dysfunction in the last 1 month	0.018	-0.123	0.137	**0.653**	-0.005	0.117
6.1	Bed - time at night in the last 1 month	0.355	0.054	-0.138	**0.522**	-0.084	0.064
6.3	Actual sleep time per night in the last 1 month (not equal to the time in bed)	0.211	0.031	0.23	**0.494**	-0.086	0.067
5.2	Frequency of daily grocery shopping and shopping during pregnancy	0.086	-0.036	0.016	0.004	**0.882**	0.103
5.3	Frequency of having to cook at least one meal a day during pregnancy	0.005	-0.014	0.013	-0.123	**0.866**	0.165
5.4	Frequency of doing daily cleaning during pregnancy every day	0.167	-0.01	0.099	-0.121	**0.809**	0.133
5.5	Frequency of doing heavy home cleaning daily	0.114	-0.182	0.132	-0.239	**0.698**	0.066
5.1	Frequency of taking care of children and the elderly daily during pregnancy	0.313	0.031	0.1	0.067	**0.52**	-0.153
2.2	Frequency of consuming foods with a high sugar content	0.01	0.096	-0.02	-0.033	0.128	**0.817**
2.3	Frequency of consuming foods with a high fat content	0.09	0.143	0.156	-0.03	0.063	**0.744**
2.1	Frequency of consuming food with a high salt content	0.033	0.179	0.166	0.015	0.042	**0.644**
2.4	Frequency of ordering take - out or dining out	0.254	-0.294	0.138	0.126	0.102	**0.491**

Table 3 Chinese version of the MHPB scale model fit indicators

Project	χ^2/df	RMSEA	RMR	SRMR	CFI	TLI	IFI
measured value	1.625	0.06	0.061	0.061	0.859	0.846	0.861
reference point	1–3	< 0.08	< 0.05	< 0.08	> 0.8	> 0.8	> 0.8

Note: Chi square is divided by the degree of freedom (χ2/df); root mean square error of approximation (RMSEA); root Mean Square Residua (RMR); standardized root mean square residual (SRMR); comparative fit index (CFI); Tucker–Lewis index (TLI); incremental fit index (IFI)

Table 4 Correlations between the MHPB scale and the HPLP - II R scale

	Total score of HPLP-II *R*	Interpersonal relationships	Health responsibilities	Stress management	Nutrition	Physical activity	Spiritual growth
Total score of MHPB	0.591**	0.373**	0.489**	0.419**	0.498**	0.524**	0.409**
Healthy diet during pregnancy	0.709**	0.457**	0.662**	0.548**	0.610**	0.480**	0.471**
Poor diet during pregnancy	0.266**	0.182**	0.215**	0.248**	0.279**	0.142*	0.193**
Exercise during pregnancy	0.330**	0.147*	0.217**	0.194**	0.273**	0.436**	0.251**
Occupational activities during pregnancy	0.012	0.067	-0.032	-0.032	-0.022	0.08	0.014
Household activities during pregnancy	0.164**	0.09	0.163**	0.097	0.140*	0.171**	0.054
Sleep during pregnancy	0.310**	0.200**	0.229**	0.237**	0.251**	0.258**	0.276**

Note: Two - tailed test, *$P < 0.05$, **$P < 0.01$

Table 5 Reliability of the Chinese version of the MHPB scale

dimension (math.)	item count (of a consignment etc.)	Revised item - total correlation coefficient	Cronbach's α coefficient	McDonald's ω coefficient
population (statistics)	36	0.351–0.858	0.837	0.848
Healthy diet during pregnancy	8	0.49–0.717	0.85	0.857
Poor diet during pregnancy	4	0.351–0.587	0.7	0.722
Exercise during pregnancy	8	0.361–0.664	0.769	0.784
Occupational activities during pregnancy	5	0.669–0.858	0.901	0.910
Household activities during pregnancy	5	0.5 to 0.778	0.86	0.87
Sleep during pregnancy	6	0.37–0.713	0.784	0.795

the model assumptions and validation. As shown in Table 3, the CFI, TLI and IFI values were slightly lower than 0.9. The presence of unexplained data variation (RMR = 0.061) indicates that the model was not perfect. Coupled with the possible underestimation of the fit index values due to the small sample size [49], these factors jointly explain this phenomenon. However, both RMSEA and SRMR showed a good level of approximate error. Considering the standardized factor loadings (0.341–0.923), composite reliability (CR) (0.727–0.914), and discriminant validity (0.31–0.681), it was considered that the data of the 6-factor structural equation model fit well, indicating that the Chinese version of the MHPB scale has acceptable validity.

Concurrent validity

Overall, 296 samples were analysed. The absolute values of the skewness and kurtosis of the total score and the scores of each dimension of the MHPB scale ranged from 0.043 to 0.554 and 0.112–1.082, respectively, and those of the total score and the scores of each dimension of the HPLP-II R scale ranged from 0.086 to 1.02 and 0.011–1.121, respectively, and the data were in line with the normal distribution. As shown in Table 4, the overall correlation between the MHPB scale and the HPLP-II R scale was moderate ($r = 0.591$, $P < 0.05$), supporting the effectiveness of the MHPB in assessing health-promoting behaviors during pregnancy. Among them, active health behaviors (such as healthy diet/health responsibility/nutrition, pregnancy-related activities/sports) had the strongest correlation and could be regarded as the key intervention points for health promotion; passive and environment-dependent behaviors (such as housework, occupational sports) or risk behaviors (such as poor diet) had a weak or no correlation with the HPLP-II R scale, and may need to be evaluated and intervened separately.

Reliability

As shown in Table 5, the Cronbach's α coefficient and McDonald's ω coefficient for the overall dimension and each dimension were > 0.70, suggesting that the internal consistency of the Chinese version of the MHPB scale was good. The retest reliability was 0.990, and the ICC was in the range of 0.873–1.000, indicating that the scale was highly stable.

Discussion

Given the lack of validated assessment tools for health promotion behaviors in the maternal population, this study is the first culturally adapted version of the MHPB scale to be translated into Chinese, culturally adapted, and evaluated for its psychometric properties. The results of this study revealed that the finalized Chinese version of the MHPB scale, which consists of 36 scored items in 6 dimensions, including healthy diet during pregnancy (8 items), poor diet during pregnancy (4 items), exercise during pregnancy (8 items), occupational activities during pregnancy (5 items), household activities during pregnancy (5 items), and sleep during pregnancy (6 items), has good psychometric properties.

Health-promoting lifestyles and health-related behaviors may vary with environmental, cultural, and linguistic changes, which emphasizes the importance of cultural and linguistic validation of measurement instruments [50]. Cultural adaptation aims to ensure the applicability and validity of scales in different cultural contexts. In this study, to better assess the lifestyles that have a greater impact on the health status of Chinese pregnant women, the MHPB scale was revised based on the characteristics of the national maternal population and with reference to relevant local and international guidelines and scales.

In the original MHPB scale, considering that "physical activity" may conflict with pregnancy, its score weight was the lowest (10%). The Chinese cultural concepts of "resting" and "fetal nurturing" during pregnancy foster a widespread cautious attitude toward physical exercise among expectant mothers and their families. A study in Shanghai, China, showed that the overall rate of insufficient physical activity among pregnant women was 47.5%, and walking was the main form of physical activity, with only 2.8% of pregnant women performing at least 150 min of moderate-intensity physical activity per week [51]. However, in traditional Chinese families, women typically assume more household responsibilities and exhibit high levels of occupational participation. Therefore, considering that unstructured exercise may be the main source of physical activity for Chinese pregnant women, and to encourage pregnant women to participate in various forms of activities, we increased the number of physical activity items and raised the score weight to 48.6%. In addition, Chinese social culture has a strong restrictive effect on smoking and alcohol consumption during the preconception and pregnancy periods. A survey of 31 provinces in China in 2017 showed that 95% of women never smoked, 4.43% quit smoking during pregnancy, and only 0.56% smoked during pregnancy [52]. Data from multiple maternal and child health hospitals in Hunan, China, showed that the proportion of active smokers during the periconception period was 2.3%, the proportion of passive smokers was 20.3%, and the proportion of drinkers was 3.0%, all of which were significantly lower than international data. Therefore, during the cultural adaptation stage, the score weights of smoking and alcohol consumption were greatly reduced (from 30–2.7%) [53]. Compared with the stronger emphasis on personal health management in Europe and America, the health behaviors of Chinese pregnant women are more influenced by cultural characteristics such as traditional concepts, family, and social roles, which in turn affect the final structure of the scale. The content validity of the scale was reviewed by an expert committee, which revealed that the scale had satisfactory face and content validity. The presurvey revealed that the scale was comprehensible and acceptable to pregnant women. The results of this study showed that 99.3% of pregnant women never smoked, and 96.6% of pregnant women never drank alcohol. These made the variability of these two dimensions extremely small in the sample, making it difficult to effectively distinguish individual differences. Retaining these dimensions would instead weaken the behavior-prediction validity of the scale in the local context. Therefore, the "smoking" and "alcohol consumption" dimensions were finally removed, ensuring the local adaptation and cultural sensitivity of the scale.

In this study, the results of both the Chinese version of the MHPB scale and the HPLP-II R scale revealed that pregnant women's health-promoting behaviors were moderate, with nutritional scores being the highest and exercise scores being the lowest, which is in line with the results of the Hungarian version of the MHPB scale [25] and the study by Yu Pengli [54].Studies from Taiwan [55], China, and Turkey [56] have reported that the health-promoting behaviors of pregnant women are at a moderate or even poor level, while reports from Iran [57] and Shandong [58], China, suggest that these behaviors are at a good level. Overall, there is still significant room for improvement in the health-promoting behaviors of pregnant women. Nutrition and sports, as the dimensions with the highest overlap between the two scales, indicated that the synergistic intervention effect of a healthy diet and regular exercise during pregnancy was stronger, and they could be regarded as the key health-promoting behaviors for attention. For example, given the overall low scores in the exercise dimension, the government, communities, and healthcare institutions should strengthen the health education on exercise for women of child-bearing age. "Household/occupational activities" had the weakest or even no correlation with the HPLP-II R scale, suggesting that such behaviors were unique or environment-dependent and were not fully captured by universal health assessment tools. Healthcare providers need to pay attention to whether there are pregnant women with excessive physical load, remind family members to share family responsibilities,

and suggest that pregnant women appropriately adjust their work positions. "Poor diet" during pregnancy had a weak correlation with the overall HPLP-II R scale and its various dimensions, which may be related to the fact that the HPLP-II R scale focuses more on positive behaviors, while the MHPB scale separately measures the "reverse indicators" of poor diet. "Sleep during pregnancy" contributes to overall health, but it has no in-depth correlation with the specific behavior dimensions of the HPLP-II R scale, indicating that improving sleep requires a combination of physiological regulation rather than simply relying on behavioral intervention. If it is assessed that a pregnant woman has a serious sleep disorder, which may be related to pregnancy-related anxiety or depression, healthcare personnel should intervene in a timely manner, provide psychological support, or refer the patient to professional mental health services.

Overall, the Chinese MHPB scale can accurately and meticulously reflect the current core health-promoting behaviors of pregnant women in the Chinese cultural context. The test content directly targets specific daily behaviors, and the test results are more stable. In addition, reverse items (accounting for 16.7% in total) have been added to the diet and exercise dimensions, which helps to reduce response bias. In contrast, items such as "stress management" and "spiritual growth" in the HPLP-II R scale, which involve long-term goals, do not conform to the Chinese language context and are difficult to understand, easily causing random filling in the test and affecting the effectiveness of the scale. In the future, it is advisable to further explore the potential links between highly independent behaviors in the scale (such as household/occupational activities and sleep) and overall health, and optimize the universality and accuracy of the scale by integrating environmental factors, individual differences, and psychological factors, so as to better serve the assessment and intervention of health-promoting behaviors during pregnancy.

Although the present study was a Chinese version of the scale with a predetermined factor structure, EFA was chosen to be conducted first rather than CFA because of the large number of entries added in the revision and the addition of the sleep during pregnancy dimension, as well as the deletion of the factors of smoking during pregnancy and drinking alcohol as a result of the item analyses, whereas the original scale was validated only for face validity. Exploratory factor analysis allows for a data-driven exploration of the factor structure without prior assumptions about the number of factors and associated indicators, treats all entries in the scale as potentially relevant to all potential factors, can be loaded on all factors [59], and is suitable for situations in which the theoretical and empirical bases are insufficient to support strong hypotheses [60]. Through exploratory factor analysis, the structural validity of the revised scale can be comprehensively assessed to provide theoretical support for subsequent studies.

Although factors with eigenvalues greater than 1 are usually considered significant in factor analysis, this criterion may sometimes be too loose and overestimate the true number of factors [61]. In this study, the scree plot is used as a graphical representation of the eigenvalues to identify the inflection point of the number of factors, which shows a slowing down of the decreasing trend from the 6th factor; the parallel analysis determines the number of factors by comparing the eigenvalue curves of the real data with the eigenvalue curves of the random data, and the intersection of the curves is at the 6th factor, suggesting that the optimal number of factors is 5. The scree plot and parallel analysis provide a different basis for decision-making. Limiting the number of factors extracted to 5 and 6 was again performed for EFA, and the results showed that compared with the five-factor model, the six-factor model performed better in terms of theoretical fit, statistical fit, and explanatory power, providing a more accurate explanation of the data structure.

CFA further validated the six-factor structural model on the basis of the model fit metrics of χ^2/df, RMSEA, SRMR, CFI, TLI, and IFI. The CFI, TLI, and IFI were approximately 0.85, which was slightly lower than the ideal value of 0.9. However, χ^2/df, RMSEA, and SRMR showed good model fit, and the overall fit of the model was acceptable. A growing body of research suggests that commonly used model fit indices are not always applicable in the context of exploratory factor analysis. Standard model fit indices such as RMSEA, SRMR, CFI, and TLI may suffer from correlated residuals and model imperfections when evaluating scales, leading to incorrect model selection [62]. Therefore, multiple metrics and methods should be considered for determining the number of factors during factor analysis rather than relying on a single model fit index to improve the reliability and validity of the findings.

In this study, the EFA categorized the positive- and negative-scoring entries of the Chinese version of the MHPB scale for the "eating during pregnancy" dimension as different factors. Interpretation of positive and negative scores in one dimension of the EFA as two different factors often occurs when the underlying structure of the scale is not as simple as initially hypothesized [63]. This is consistent with a broader understanding of factor analysis in that different scoring methods can yield different insights into the underlying structure of the measure, thereby allowing the researcher to gain a more nuanced understanding of the structure being assessed. This suggests that we must be mindful of the potential impact

of scoring choices on research findings and thus remain open-minded when interpreting factor structure [64].

The main limitation of this study is that the deletion of the dimensions of smoking and alcohol consumption may affect the comprehensiveness of the assessment of pregnant women's health behaviors in different cultures or countries, although it makes the scale more focused on health-promoting behaviors that can effectively differentiate between individual differences in pregnant Chinese women. Second, considering the complexity of psychological conditions, maternal mental health status was not included in this study.

This study has several limitations. First, removal of the "smoking" and "alcohol consumption" dimensions helps the Chinese version of the MHPB scale to focus more on health-promoting behaviors that can effectively distinguish individual differences among Chinese pregnant women. However, it may affect the cross-cultural universality in regions where such behaviors are more prevalent and the direct comparability of research. Foreign studies have shown that although the smoking [65] and alcohol consumption [66] rates of women decrease after pregnancy, a considerable number of women still continue to smoke and drink during pregnancy. In a study in Northern Ireland, the smoking rate during pregnancy was 13.2% [67]. A study in Poland reported that 24% of women were exposed to second-hand smoke during pregnancy [68]. In the United States, the alcohol consumption rate during pregnancy was 11.5%, and 3.9% of pregnant women reported binge-drinking behavior [69]. In the future, we will re-evaluate the applicability of these two dimensions in different cultural backgrounds, selectively attach the smoking/alcohol consumption module of the original scale, so as to balance local validity and cross-cultural consistency. Or consider changing the assessment of active smoking/alcohol consumption to the assessment of environmental risk exposure caused by "second-hand smoke" and the intake of traditional Chinese medicinal wines containing alcohol (such as rice wine and medicinal diet wine), instead of deleting the relevant dimensions. Second, the sample was collected only from two hospitals in two cities, and 75% of the pregnant women had a high-school education or above. The limited sample size and representativeness may affect the generalizability to rural areas and populations with a lower educational level. In the future, it is necessary to further expand the survey area and sample size. Third, considering the complexity of psychological conditions and that the MHPB scale focuses on observable and intervenable explicit behaviors, the mental health status of pregnant women was not included in this study. However, given the importance of the interaction between physical and mental health, future revisions of the scale will explore how to effectively integrate mental health indicators.

Conclusion

The Chinese version of the MHPB scale not only enriches the theoretical basis of health promotion but also provides a multidimensional perspective for assessing maternal health-promoting behaviors, making it a valid and reliable tool for evaluating the level of maternal health promotion. Further research is needed to provide stronger evidence for the validity of the scale, such as reassessing the applicability of the "smoking during pregnancy" and "drinking during pregnancy" dimensions and exploring the relationship between more health-promoting behaviors and the MHPB scale to assess its validity comprehensively across different countries and cultures. The psychometric properties of the MHPB in different countries and cultures can be assessed to build a more comprehensive assessment system for maternal health-promoting behaviors and provide more data support for cross-cultural health-promoting behavior research.

Abbreviations

MHPB	Maternal Health Promoting Behavior Scale
CVI	Content Validity Index
EFA	Exploratory Factor Analysis
CFA	Confirmatory factor analysis
HPM	Health Promotion model
HPLP	Health-Promoting Lifestyle Profile
WHO	World Health Organization
S-CVI	Scale-level Content Validity Index
I-CVI	Item-level Content Validity Index
CR	Critical Ratio
KMO	Kaiser–Meyer–Olkin
χ^2/df	Chi-square/degree of freedom
RMSEA	The Root Mean Square Error of Approximation
CFI	Comparative Fit Index
TLI	Tucker-lewis Index
IFI	Incremental Fit Index
CITC	Corrected Item-Total Correlation
ICC	Interclass Correlation Coefficient

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Author contributions

H.W. and Y.Z.conceptualized and designed the study, conducted data collection, contributed to data analysis and interpretation, drafted the manuscript, wrote and reviewed the article. J.Z. conceptualized and designed the study, reviewing the prepared manuscript. Y.G. contributed to the analysis and interpretation of the data. Z.L. screened and recruited participants for the study. X.R. and T.H. contributed to the concept and design of the study. All authors read and approved the final manuscript.

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Data availability
The data used in this study can be obtained from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The Ethics Committee of Shenzhen Renhe Hospital approved this study (No. 2023–002). All methods were performed in accordance with the relevant guidelines and regulations of the Helsinki Declaration. Before collecting data, we obtained informed consent from all respondents.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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