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Barriers, Not Benefits: Perceived Barriers as the Primary Predictor of Physical Activity Guideline Adherence among Pregnant Women in Three Chinese Provinces: A Cross-Sectional Study

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Research Article

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Abstract

Background

Despite well-documented benefits of physical activity (PA) during pregnancy, global adherence to international guidelines remains low. While traditional health behavior theories emphasize perceived benefits and self-efficacy as primary motivators, emerging evidence suggests immediate, tangible barriers may exert stronger influence, particularly in resource-limited settings. However, few studies have examined these relationships in Chinese pregnant women, and multi-center studies verifying predictive mechanisms across diverse regional contexts are scarce.

Objective

This study aimed to (1) describe PA patterns and provincial variations among pregnant women in three Chinese provinces, and (2) identify independent predictors of meeting international PA recommendations.

Methods

A cross-sectional survey of 335 pregnant women across three provinces validated Chinese versions of the Pregnancy Physical Activity Questionnaire, Exercise Benefits/Barriers Scale, and Pregnancy Exercise Self-Efficacy Scale. PA adequacy was defined as meeting WHO guidelines (≥ 150 min moderate-intensity activity per week). Multivariate logistic regression adjusted for maternal age, gestational age, and education level.

Results

Provincial variations existed in sedentary time and light-to-moderate PA intensity ($p < 0.05$), but overall adequacy rates showed no significant inter-provincial difference ($p > 0.05$). Perceived barriers, benefits, and self-efficacy were homogeneous across provinces (all $p > 0.05$). Univariate analyses revealed all three factors as significant predictors: barriers (OR = 0.92, 95% CI 0.88–0.97, $p < 0.001$), benefits (OR = 1.03, 95% CI 1.01–1.05, $p = 0.007$), and self-efficacy (OR = 1.05, 95% CI 1.01–1.10, $p = 0.024$). However, multivariate analysis identified only perceived barriers as significant (adjusted OR = 0.93, 95% CI 0.88–0.98, $p = 0.004$), while benefits ($p = 0.368$) and self-efficacy ($p = 0.137$) were non-significant when barriers were accounted for. The model explained 12.9% of variance (Nagelkerke R^2=0.129).

Conclusions

These findings challenge the “benefits-first” approach to prenatal health promotion. Perceived barriers demonstrate greater influence on PA behavior than Perceived benefits or self-efficacy, suggesting that removing practical barriers may be more effective than solely improving health literacy or self-confidence. Cross-provincial consistency supports generalizability across diverse Chinese contexts. The cross-sectional design limits causal inferences, and the model's modest explanatory power indicates the need to explore additional factors. Future longitudinal studies and randomized controlled trials should evaluate barrier-reduction strategies.

Introduction

Physical activity (PA) is any movement generated by skeletal muscle contractions that significantly raises caloric needs beyond resting energy expenditure[1] .Encouraging physical activity is a global health priority because it can alleviate non-communicable disease burdens and enhance population health[2]. Regular physical activity has been shown to prevent and manage noncommunicable diseases (NCDs) like heart disease, stroke, diabetes, and breast and colon cancer.Additionally, it helps prevent hypertension, obesity, and overweight, as well as improve mental health, life quality, and well-being[3] .Engaging in physical activity during pregnancy offers advantages for both maternal and fetal health, including a decreased risk of adverse outcomes like gestational diabetes, hypertension, and preeclampsia, as well as reduced overweight and obesity and enhanced mental well-being.Engaging in regular physical activity during pregnancy effectively mitigates both short-term and long-term complications for

newborns[4, 5].The World Health Organization has issued guidelines recommending that all pregnant women without contraindications participate in at least 150 minutes of moderate-intensity aerobic activity per week throughout pregnancy to optimize maternal and fetal outcomes[5].

Despite global and Chinese recommendations for pregnant women to engage in at least 150 minutes of moderate-intensity physical activity per week, most do not meet these guidelines[6, 7]. A recent systematic review estimated that only about 21% of Chinese pregnant women achieve recommended PA levels,with substantial regional and trimester differences[7].Many studies are limited to a single center or region, typically conducted in one city such as Tianjin, Shanghai, or Guangzhou, or within a single hospital[8–10],complicating the differentiation between environmental specificity and behavioral universality. China's vast territory and diverse cultural and economic factors may lead to varying levels of physical activity, and whether the psychological mechanisms influencing behavior possess cross-situational robustness remains unclear.

Nonetheless, there is still a notable theoretical gap in grasping the hierarchical relationships between these psychosocial factors.While exercise self-efficacy and perceived benefits are often identified as distant cognitive predictors[11–13], recent findings in behavioral economics indicate that immediate barriers may act as proximal “gatekeepers”, potentially overshadowing these abstract cognitive motivations[14, 15]. During pregnancy, a time marked by increased physical discomfort and limited time, immediate physical barriers such as fatigue and symptoms may more strongly inhibit behavior compared to the abstract, future benefits of physical activity[16, 17]. Thus, contrary to the prevailing “benefits-first” paradigm, we hypothesize that perceived barriers, rather than self-efficacy or perceived benefits, may serve as the sole independent predictor of PA adequacy among Chinese pregnant women, particularly when structural and interpersonal barriers are prevalent.

Therefore, this study aimed to: (1) describe the patterns and provincial variations of PA among pregnant women in three Chinese provinces; and (2) identify the independent predictors of PA adequacy, specifically testing the hypothesis that perceived barriers, rather than self-efficacy or benefits, represent the primary determinant of meeting international PA recommendations.

Method

Study design and participants

This cross-sectional multicenter survey was conducted from January 27 to February 21, 2024, with 335 participants from Zhejiang, Guangdong, and Shanxi Provinces completing the survey via the “Questionnaire Star” online platform. The study included pregnant women registered for routine prenatal care at the participating hospitals.Eligible participants were women aged 20 to 45 with a singleton pregnancy, no history of habitual abortion or preterm birth,and no premature rupture of membranes,persistent vaginal bleeding, placenta previa, severe anemia,systemic diseases, mental illness,or cognitive impairment.Additionally,they needed to comprehend the study's purpose and procedures and participate voluntarily.Women with incomplete or inconsistent data submissions were excluded.

Ethical approval

The ethics committee of the Philippine Women's University approved the study protocol (ERB2024_007).Researchers explained the study's significance and purpose, assessed eligibility via medical evaluation, and inquired about participants' willingness to join the survey.Participants scanned a QR code to access an electronic questionnaire, which outlined the study's objectives, procedures, voluntary nature, withdrawal rights, risks, benefits, data confidentiality, privacy measures, contact details, and distinctions between physical activity and exercise. Completion of all sections was mandatory, and submissions that were incomplete or illogical were rejected.

Sampling method and sample size

For estimating the prevalence of physical activity guideline compliance, we used data from our preliminary study conducted in Guangdong Province in 2017,which reported a compliance rate of 22.1%[18]. Applying the proportion estimation formula, $n = Z^2 \times p(1-p) / E^2$, with Z = 1.96 for a 95% confidence level, p = 0.221 as the expected compliance rate, and E = 0.05 as the margin of error, the calculated sample size is 265 participants.The target sample size was adjusted to 295 participants to account for an estimated 10% attrition rate.

Measures

The Chinese version of the Pregnancy Physical Activity Questionnaire (PPAQ) was utilized to assess Pregnancy Physical Activity.The Pregnancy Physical Activity Questionnaire (PPAQ) is globally utilized to assess the duration, frequency, and intensity of physical activity during pregnancy[19]. The Chinese adaptation of the PPAQ comprises 32 items, including 13 related to housework and caregiving, 5 to occupational activities, 8 to sports, 3 to transportation, and 3 to inactivity. Based on energy consumption, the 32 activities are categorized as sedentary (<1.5 METs), low-intensity (1.5-2.9 METs), moderate-intensity (3.0-6.0 METs), and high-intensity (>6.0 METs)[20].

The Exercise Benefits/Barriers Scale (EBBS) was utilized to assess exercise benefits and barriers. Sechrist et al. (1987) created the EBBS to evaluate individuals' perceptions of exercise benefits and barriers[21] .The Scale comprises 43 items that can be scored and utilized either as a unified scale or divided into two distinct scales. The Exercise Benefits Subscale has 29 items, and the Exercise Barriers Subscale has 14 items.The instrument has a four-response, forced-choice Likert-type format with responses ranging from 4 (strongly agree) to 1 (strongly disagree).

The Chinese version of the Pregnancy Exercise Self-Efficacy Scale (P-ESES), comprising 10 items, was used to assess pregnancy exercise self-efficacy.Bland et al. (2013) revised the P-ESES, and Yang et al. (2017) performed a cross-cultural adaptation and validation of the Pregnancy Exercise Self-Efficacy Scale[22].The scale has 1 dimension and 10 items. The options for each item are “strongly agree,” “agree,” “neutral,” “disagree,” and “strongly disagree.” The corresponding points are 5, 4, 3, 2, and 1 points, respectively.

Additional data were gathered concurrently through structured questionnaires, covering sociodemographic details like age, education, employment status, residence, and family income, alongside obstetric information such as gestational age and delivery count.Pregnant women's sociodemographic and obstetric information and the three scales were integrated into an electronic questionnaire, which was released using the “Questionnaire Star” platform.After the electronic questionnaire was released, a QR code or link was generated.

Statistical analysis

The e-questionnaire in an Excel file was directly imported into SPSS 26.0 for analysis. The participants' characteristics were presented as descriptive statistics.Continuous variables were described using the mean and standard deviation for normal distributions, and the median with interquartile range for non-normal distributions. Categorical variables were expressed as frequencies with corresponding percentages and evaluated using the chi-square test. Physical activity levels, exercise benefits/barriers, and self-efficacy across regions were analyzed using analysis of variance or rank-sum tests.The study employed Spearman's correlation analysis to investigate the associations between exercise facilitation/barrier factors, exercise self-efficacy, and the exercise levels of pregnant women.Logistic regression analyses, both univariate and multivariate, were conducted to identify factors affecting the achievement of internationally recommended physical activity levels during pregnancy.

Results

In total, 335 women completed valid questionnaires on the “Questionnaire Star” online platform from 3 provinces in China. Among them, 149 (44.5%) were from Zhejiang Province (in eastern China), 109 (32.5%) were from Guangdong Province (in southern China), and 77 (23%) were from Shanxi Province (in northwestern China).

Characteristics of the participants

Table 1 lists the sociodemographic and obstetric characteristics of the study participants.The mean age was 30.57 ± 3.498 years, the mean height was 161.18 ± 5.528 cm, the mean pre-pregnancy weight was 55.092 ± 8.089 kg, and the mean current weight was 66.627 ± 8.87 kg, the mean gestational week was 34.289±4.8725 weeks.Most participants had a tertiary education (n=259, 77.3%).Most participants were in late pregnancy (n=317, 94.6%), and they were still working (n=227, 67.8%).Most of the women were nulliparous(n=244,72.8%) and living in the urban area(n=294,87.8%) ,44.3%(n=144) of them co-residence with parents/in-laws.60% of the participants(n=201) had an annual household income between 100k and 300k RMB.

Table 1. Characteristics of the participants (n = 335)

Variables	Frequency
Level of education, n (%)	
Junior high and below	14(4.2%)
High school/Technical secondary	34(10.1%)
College/Undergraduate	259(77.3%)
Graduate	28(8.4%)
Current employment status, n (%)	
Employed	227(67.8%)
Unemployed	108(32.2%)
Current stage of pregnancy, n (%)	
First trimester(≤13+6 weeks)	6(1.8%)
Second trimester(14~27+6)	12(3.6%)
Third trimester(≥28 weeks)	317(94.6%)
Parity, n (%)	
Primipara	244(72.8%)
Multipara	91(27.2%)
Residence type, n (%)	
Urban	294(87.8%)
Rural	41(12.2%)
living arrangements, n (%)	
co-residence with parents/in-laws	144(43.0%)
Living separately from parents/in-laws	191(57.0%)
Annual household income(RMB), n (%)	
< 100k	72(21.5%)
100k□300k	201(60%)
>300k	62(18.5%)

Participants' physical activity levels

The participants' Physical Activity levels and patterns are shown in Table 2.The participants were generally physically inactive, with most sedentary and engaging in low-intensity physical activities, fewer engaging in moderate-intensity physical activities, and almost no engaging in high-intensity physical activities.Using the metabolic equivalent to measure total energy expenditure, the mean total energy expenditure was 183.56 Met-hours/week, and the median was 173.73(129.73,224.63) Met-hours/week.Among the 335 pregnant women, there were 50 who did not exercise any form (14.9%).Ninety-seven participants (29%) engaged in over 150 minutes of physical activity weekly, equivalent to 450 Met-minutes or 7.5 Met-hours[23,24]. In line with the World Health Organization (2020) Guidelines[5], these 97 individuals achieved the recommended physical activity level during pregnancy.Walking was the most common form of exercise for pregnant women, reported by 265 participants, accounting for 79.1% of the total participants.

In terms of activity intensity, pregnant women consume more than half of their daily energy from sedentary activities.Low-intensity activities account for 27.1% of the total daily energy expenditure, and moderate-intensity and above activities account for 18.4%, indicating that pregnant women are generally in a state of physical inactivity.Nearly 60% of energy is consumed in domestic

activities, followed by occupational activities.Energy expenditure in transportation accounts for 9.8% of total energy expenditure, and only 3.1% is consumed in exercise.

Table 2 The PA levels of the participants (n=335)

Variable	Mean	SD	Median (P50)	P25	P75	Min	Max	Percent of TEE(%)
TEE	183.56	87.01	173.73	129.73	224.63	35.63	658.28	100
Divided by activity intensity								
SED	100.12	44.67	100.45	60.73	135.45	2.63	195.83	54.5
LPA	49.78	38.61	39.03	20.65	69.13	4.03	216.30	27.1
MPA	33.09	43.08	18.85	8.53	40.18	0.00	315.27	18.0
VPA	0.57	2.16	0.00	0.00	0.00	0.00	20.25	0.4
Divided by activity domain								
DPA	109.87	58.85	96.60	70.53	131.60	22.05	397.95	59.8
TPA	18.01	19.06	12.25	7.00	21.00	0.00	126.00	9.8
OPA	50.13	47.48	59.85	0.00	76.83	0.00	373.00	27.3
LTPA	5.55	6.64	3.43	0.80	8.25	0.00	46.40	3.1

PA level,exercise benefits, exercise barriers, and exercise self-efficacy from the 3 provinces

Table 3 showed significant differences among Sedentary behavior, Low-intensity PA, and Moderate-intensity PA in different provinces, P<0.05.Pairwise comparisons revealed that Shanxi Province had a significantly higher Sedentary score of 112 (73.33, 137.64) compared to Guangdong Province's score of 88.2 (54.51, 125.3), with p=0.03.Low-intensity PA was 33.95 (19.34,55.48) in Zhejiang Province, which was significantly lower than 53.73 (26.95, 87.5) in Guangdong Province, p<0.001.29.75 (16.8, 61.08) in Shanxi Province was significantly lower than 53.73 (26.95, 87.5) in Guangdong Province, p=0.002.Moderate-intensity PA is 17.75 (7.73,34.41) in Zhejiang Province, which was significantly lower than 22.05 (12.7, 49.03) in Guangdong Province, p=0.046.The differences in Total PA, VPA, DPA, TPA, OPA, LTPA (exercise), E-Benefits, E-Barriers, and P-ESES in three provinces were insignificant, P>0.05.

Table 3 The comparison of the PA level, Exercise Benefits/Barriers, and Self-efficacy

In three chosen hospitals (n =335)

	Zhejiang (n=149)	Guangdong (n=109)	Shanxi (n=77)	H	P
Total PA	162.35(126.5,219.91)	183.33(135.56,232.26)	178.33(123.19,228.69)	2.414	0.299
SED	112(62.13,141.75)	88.2(54.51,125.3)	112(73.33,137.64)[a]	8.088	**0.018**
LPA	33.95(19.34,55.48)[a]	53.73(26.95,87.5)	29.75(16.8,61.08)[a]	17.933	**0.0001**
MPA	17.75(7.73,34.41)[a]	22.05(12.7,49.03)	16(6.49,37.34)	7.481	**0.024**
VPA	0(0,0)	0(0,0)	0(0,0)	1.82	0.402
DPA	93.45(71.05,126.09)	107.1(71.23,153.83)	89.25(65.8,122.85)	5.657	0.059
TPA	12.25(7,21)	12.25(7,22.75)	13.13(4.38,21.88)	0.015	0.992
OPA	59.85(0,74.11)	56(3.85,76.83)	67.2(6.65,76.83)	3.848	0.146
LTPA	3.55(0.8,8)	3.28(0.8,8)	2.4(0.8,10.35)	0.062	0.969
Exercise-Benefits	87(83,87)	86(82,87)	86(81,91.5)	0.088	0.957
Exercise-Barriers	30(28,32)	29(27.5,32)	29(28,32)	1.20	0.549
P-ESES	37(32,40)	38(33.5,40)	37(32,40)	1.173	0.556

a: Pairwise comparison after Bonferroni correction, compared with Guangdong Province, P<0.05

Figure 1 illustrates the comparison of physical activity compliance rates among pregnant women across three provinces: Guangdong (n=109), Zhejiang (n=149), and Shanxi (n=77).The analysis revealed no statistically significant differences among the three provinces ($\chi^2 = 2.005$, df = 2, p = 0.367).Error bars indicate 95% confidence intervals.

Factors Associated with Physical Activity Compliance

Table 4 displays the logistic regression analyses, both univariate and multivariate, examining factors linked to compliance with physical activity.Univariate analysis revealed significant associations between physical activity compliance and three psychosocial variables: exercise benefits score (OR = 1.03, 95% CI 1.01–1.05, p = 0.007), exercise barriers score (OR = 0.92, 95% CI 0.88–0.97, p < 0.001), and self-efficacy score (OR = 1.05, 95% CI 1.01–1.10, p = 0.024).No demographic, obstetric, or regional factors showed significant associations with physical activity compliance in univariate analysis.

In a multivariate analysis accounting for demographic, obstetric, psychosocial, and regional factors, the exercise barriers score was the only variable that remained statistically significant (OR = 0.93, 95% CI 0.88–0.98, p = .004).A one-point increase in the exercise barriers score correlated with a 7% reduction in the likelihood of meeting physical activity guidelines. In the multivariate model, the exercise benefits score (OR = 1.01, 95% CI 0.98–1.04, p = 0.368) and self-efficacy score (OR = 1.05, 95% CI 0.99–1.11, p = 0.137) were not statistically significant, indicating that their univariate associations were confounded by exercise barriers.

Table 4 Univariate and multivariate logistic regression analysis of factors associated with physical activity compliance among pregnant women (n = 335)

Variable	Univariate Analysis	Multivariate Analysis
	OR (95% CI), p	OR (95% CI), p
Demographic factors		
Age (years)	1.03 (0.96–1.10), 0.461	1.02 (0.95–1.11), 0.552
Education (Ref: Junior high and below)		
High school/Technical secondary	1.03 (0.47–2.23), 0.951	2.54 (0.43–14.89), 0.303
College/Undergraduate	0.85 (0.49–1.48), 0.567	1.92 (0.36–10.12), 0.444
Graduate	1.96 (0.89–4.31), 0.095	2.40 (0.37–15.77), 0.362
Employment status: Employed (Ref: Unemployed)	0.89 (0.54–1.47), 0.656	0.84 (0.48–1.47), 0.545
Residence: Urban (Ref: Rural)	0.67 (0.34–1.33), 0.252	0.48 (0.22–1.06), 0.069
Living arrangement: Living separately (Ref: Living together)	1.11 (0.69–1.79), 0.680	1.07 (0.62–1.86), 0.799
Annual income (Ref: Below 100K)		
100-300K	1.05 (0.65–1.70), 0.844	1.04 (0.51–2.12), 0.907
Above 300K	1.21 (0.67–2.20), 0.526	0.98 (0.40–2.42), 0.968
Obstetric factors		
Gestational weeks	1.00 (0.95–1.05), 0.918	0.99 (0.90–1.09), 0.842
Trimester (Ref: First trimester)		
Second trimester	1.79 (0.56–5.80), 0.329	9.73 (0.55–171.99), 0.120
Third trimester	0.81 (0.29–2.21), 0.674	4.30 (0.17–110.22), 0.378
Parity: Multipara (Ref: Primipara)	0.72 (0.41–1.25), 0.240	0.73 (0.36–1.48), 0.383
Psychosocial factors		
Exercise benefits score	1.03 (1.01–1.05), 0.007**	1.01 (0.98–1.04), 0.368
Exercise barriers score	0.92(0.88–0.97), <0.001***	0.93 (0.88–0.98), 0.004**
Self-efficacy score	1.05 (1.01–1.10), 0.024*	1.05 (0.99–1.11), 0.137
Regional factors		
Province (Ref: Guangdong)		
Zhejiang	0.94 (0.58–1.51), 0.782	0.94 (0.48–1.82), 0.849
Shanxi	1.45 (0.84–2.50), 0.179	1.48 (0.69–3.17), 0.308

Abbreviations: OR (Odds Ratio); CI (Confidence Interval); Ref (Reference category).

Note: Compliance with physical activity was defined as achieving at least 7.5 MET-hours weekly.Variables with a p-value less than 0.20 in the univariate analysis were incorporated into the multivariate model.Model fit statistics: -2 Log likelihood = 372.95; Cox & Snell R^2 = 0.086; Nagelkerke R^2 = 0.129; Model χ^2 = 30.22 (df = 18), p = 0.035.

Significance levels are indicated as follows: * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$.

Figure 2 presents the Spearman correlation coefficients between physical activity (exercise compliance), exercise benefits score, exercise barriers score, and pregnancy exercise self-efficacy (P-ESES) in a sample of 335 pregnant women.Color intensity indicates correlation strength and direction, with red signifying positive and blue indicating negative correlations.Significance levels are denoted as follows: * for $p < 0.05$, ** for $p < 0.01$, *** for $p < 0.001$, and ns for not significant.

Discussion

This multi-center study examined physical activity patterns and their psychosocial determinants among 335 pregnant women across Guangdong, Zhejiang, and Shanxi provinces in China.Our study identified three significant insights.Only 29% of pregnant women met the physical activity guidelines, indicating that the majority did not reach the recommended ≥7.5 MET-hours per week.Second, despite observing provincial differences in sedentary behavior and activity intensity distributions, the compliance rates were notably similar across the three provinces (25.7%, 28.2%, and 35.1%, respectively; $\chi^2 = 2.005$, $p = 0.367$).Exercise barriers were identified as the only independent predictor of physical activity compliance in multivariate analysis (OR = 0.93, 95% CI 0.88–0.98, $p = 0.004$), with exercise benefits and self-efficacy affecting behavior indirectly through barrier perception.

Our study's compliance rate of 29.0% aligns with earlier findings from Western and Asian populations, indicating that insufficient physical activity during pregnancy is a worldwide public health issue. Hesketh and Evenson (2016) found that 23.4% of pregnant women in the United States adhered to the American College of Obstetricians and Gynecologists (ACOG) guidelines[25]. Comparable adherence rates were observed in Europe, with 20.3% in Spain[26] and 30.7% in France[27]. In South Africa, the rate was 25.7% of pregnant women's physical activity reached the level recommended by the guidelines [28]. Previous studies in China have reported low levels of physical activity among pregnant women.For instance, Zhang et al., (2014)found that only 11.1% of pregnant women in Tianjin met the physical activity recommendations[29]. The consistently low compliance rates across diverse cultural and geographic settings suggest that pregnancy itself presents universal barriers to physical activity engagement, including physical discomfort, fatigue, and concerns about fetal safety.

Our study revealed an interesting contrast between the provincial differences in activity intensity distributions and the uniformity in overall compliance rates. Table 3 showed significant differences among provinces in sedentary behavior, light-intensity activity, and moderate-intensity activity (all $p < 0.05$). Yet, the proportions meeting the recommended guidelines were remarkably similar across Guangdong, Zhejiang, and Shanxi ($\chi^2 = 2.005$, $p=0.367$). This pattern suggests that women may adopt different behavioral strategies to cope with pregnancy-related physical changes depending on their local context, while ultimately achieving comparable overall activity levels. For example, women in one province may compensate for higher sedentary time with more structured exercise, while those in another province may accumulate activity through household tasks and walking. The cultural homogeneity in pregnancy-related beliefs and practices across China may override regional differences in lifestyle and economic development, contributing to similar compliance rates despite different activity patterns.

The clearest finding from our study was the dominant role of exercise barriers.In a multivariate analysis accounting for demographic, obstetric, psychosocial, and regional variables, the exercise barriers score was the only factor that remained statistically significant (OR = 0.93, 95% CI 0.88–0.98, $p = 0.004$). Each one-point increase in this score corresponded to a 7% reduction in the likelihood of meeting physical activity guidelines.This aligns with the Health Belief Model (HBM), which identifies perceived barriers as among the strongest determinants of health behavior adoption[30]. Pregnant women encounter distinct physical and psychological challenges that can hinder regular activity, including concerns about fetal safety, physical discomforts like nausea and back pain, time limitations, and insufficient social support[29,31]. Our results suggest that these perceived barriers exert a stronger influence on physical activity behavior than sociodemographic characteristics or motivational factors like perceived benefits and self-efficacy.

The shift from significant to non-significant results in exercise benefits and self-efficacy when moving from univariate to multivariate analysis offers valuable insights into the mechanisms underlying pregnancy physical activity. In univariate analysis, both exercise benefits score (OR = 1.03, $p = 0.007$) and self-efficacy score (OR=1.05, $p=0.024$) were significantly associated with physical activity compliance.Both lost statistical significance in the multivariate model when exercise barriers were included ($p = 0.368$ and $p = 0.137$, respectively). The correlation matrix (Figure 2) helps explain this pattern: exercise benefits were negatively correlated with exercise barriers ($r = -0.250$, $p < 0.001$), while self-efficacy was strongly positively correlated with exercise benefits ($r = 0.576$, $p < 0.001$) but not significantly correlated with exercise barriers ($r = -0.086$, ns).This pattern is consistent with a mediation model wherein exercise benefits and self-efficacy influence physical activity indirectly through barrier perception, with barriers serving as the more proximal determinant of behavior [32,33].

Our findings have important theoretical implications for understanding physical activity behavior during pregnancy. The dominance of exercise barriers over self-efficacy challenges the traditional Social Cognitive Theory (SCT) perspective, which posits self-efficacy as the primary determinant of health behavior [34].The negative correlation between exercise barriers and physical activity ($r = -0.181$)

is similar in magnitude to the positive correlation between self-efficacy and physical activity (r = 0.206).More critically, in the multivariate model, barriers emerged as the sole significant predictor while both self-efficacy and benefits lost significance—suggesting that the unique explanatory power of barriers subsumes the effects of these motivational factors.This indicates that real-world barriers may be more determinant of physical activity behavior than subjective beliefs, posing an empirical challenge to the "self-efficacy priority" view of SCT. It suggests that, for exercise adherence during pregnancy, what a woman cannot do due to external constraints may be more influential than what she believes she can do.

This has profound implications for intervention design, suggesting a shift from solely bolstering individual beliefs to systematically identifying and addressing contextual barriers. Our data suggest that during pregnancy, barriers may be largely externally determined—physical symptoms, time constraints, family opposition, safety concerns—rather than reflecting internal confidence deficits. This interpretation is consistent with Harrison et al., (2018), who found that pregnancy-specific barriers often exist independently of women's exercise capabilities[11]. Furthermore, the strong correlation between exercise benefits and self-efficacy (r = 0.576) supports Bandura A.(1997)conceptualization of reciprocal determinism, wherein outcome expectations and efficacy expectations reinforce each other[35]. However, our multivariate findings suggest that this reinforcing cycle may be insufficient to overcome significant perceived barriers.

Our findings have important implications for prenatal care and public health interventions.First, healthcare providers should prioritize routine assessment of exercise barriers during prenatal visits, as they represent the strongest predictor of meeting physical activity guidelines.Instruments like the Exercise Benefits and Barriers Scale,validated in this study, are readily applicable in clinical settings.Second, counseling should be individualized to address specific barriers identified by each pregnant woman, rather than providing generic recommendations to "exercise more." For example, for women with safety concerns, providers can offer evidence-based reassurance and specific safety guidelines[11]; for those with physical discomfort, appropriate exercise modifications can be recommended; and for those with time constraints, time-efficient exercise options can be suggested.Third, the lack of provincial differences in compliance rates suggests that barrier-focused interventions may have broad applicability across diverse regions in China, supporting the development of national-level physical activity promotion programs for pregnant women.

This study has several strengths. The multicenter design spanning three diverse provinces (Guangdong, Zhejiang, and Shaanxi) enhances generalizability across China's geographic and economic contexts. The sample size (n = 335) provided adequate statistical power, and the comprehensive assessment of demographic, obstetric, psychosocial, and regional factors—using validated measures—allowed us to identify exercise barriers as the sole significant predictor while controlling for confounders.

It is important to acknowledge several limitations.The cross-sectional design limits causal inference, preventing determination of whether barriers lead to low activity or the reverse.The predominance of third-trimester participants (94.6%) limits our understanding of how predictors may vary across pregnancy stages.Physical activity was evaluated through a self-reported single-item compliance measure, which is susceptible to recall bias and social desirability; using objective tools like accelerometers would be more ideal. Finally, the relatively homogeneous sample (predominantly urban, college-educated, middle-income) may limit generalizability to rural or less educated populations.

Future research should address these limitations through longitudinal designs tracking physical activity patterns across pregnancy trimesters.Objective measures, such as accelerometers, would complement self-report data and provide more accurate assessments.Intervention studies are needed to test the effectiveness of barrier-reduction strategies, particularly randomized controlled trials comparing barrier-focused counseling versus standard care.Additionally, qualitative research could provide deeper insights into the specific content and sources of exercise barriers in the Chinese cultural context, informing the development of culturally tailored interventions.

In conclusion, this study reveals low rates of physical activity compliance among Chinese pregnant women, with exercise barriers identified as the primary and most actionable determinant.The lack of provincial differences suggests that barrier-focused interventions may have broad applicability across diverse regions.Healthcare providers should prioritize routine barrier assessment and tailored counseling over generic recommendations.Addressing exercise barriers is crucial for enhancing pregnancy outcomes, given the established benefits of physical activity for both maternal and fetal health.

Abbreviations

MET=The metabolic equivalent of task TEE=Total energy expenditure

SED:Sedentary Behavior LPA:Low-intensity PA MPA:Moderate-intensity PA

VPA: Vigorous-intensity PA DPA:Domestic PA TPA: Transportation PA

OPA: Occupational PA LTPA:Leisure time PA（mainly refers to exercise）

Declarations

Ethics approval and consent to participate

The study complied with the requirements of the Helsinki Declaration and was approved by the Philippine Women's University approved the study protocol (ERB2024_007). The researcher obtained informed consent from all participants involved in this study.

Availability of data and materials

The data in this study comes from the doctoral dissertation (Philippine Women's University, 2024, printed archive, unpublished). Due to the large amount of data and the different research dimensions involved, it will be published in two separate papers: this paper focuses on the inter-provincial comparison of physical activity and the exploration of the mechanism of influence of PA compliance; the validation of the mixed method of qualitative and quantitative data will also be published in a separate paper. They are available from the corresponding author upon reasonable request after the two papers are published.

Competing interests

This research was not funded, and all the authors declare no competing financial interests.

Authors' contributions

JL conceived and designed the study, supervised data collection, analyzed the data, and drafted the manuscript. YRW, XHL, and HRL conducted the investigation. JS contributed to the study design and critically revised the manuscript. All authors reviewed and approved the final manuscript.

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Clinical Trial Number

Not applicable.

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Figures

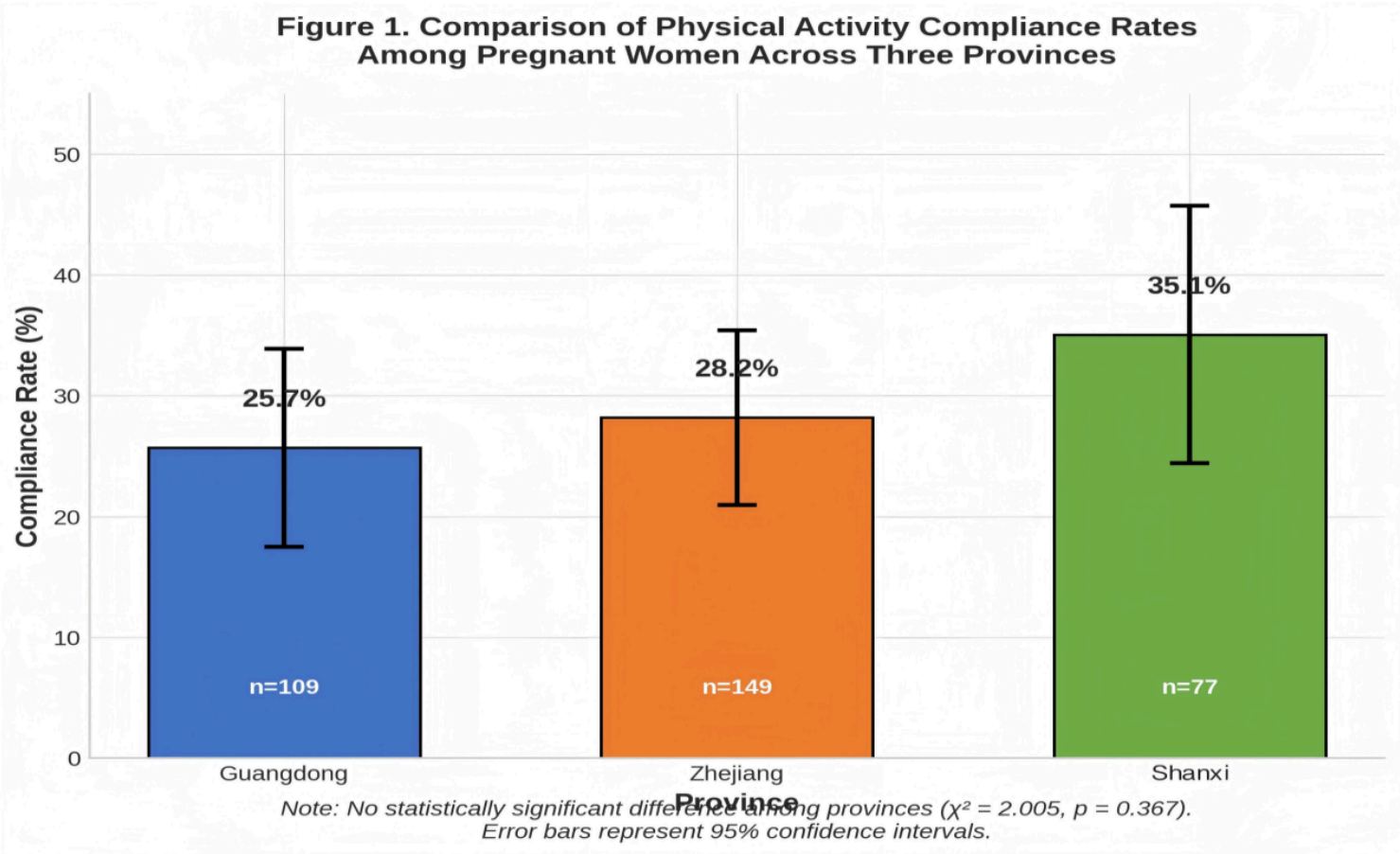

Figure 1

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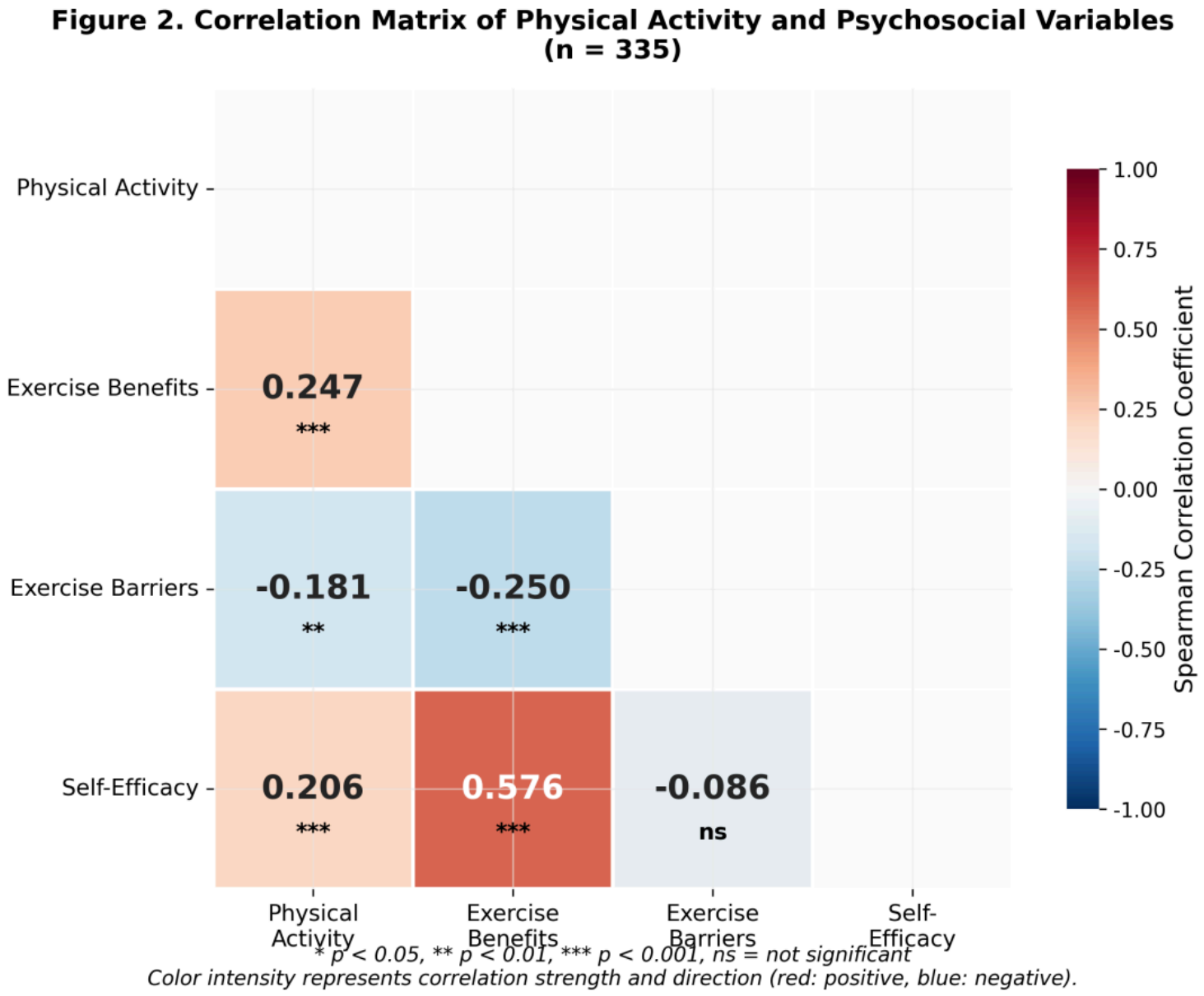

Figure 2

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