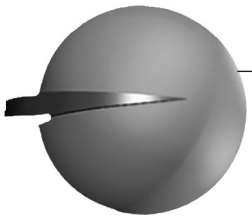

Original Article

The Evidence Base in Exercise Knowledge of Pregnant Women: A Latent Class Analysis

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Key words

exercise knowledge, pregnant women, exercise principles, latent class analysis, item analysis

ABSTRACT

Background: Exercise has many benefits for women with uncomplicated pregnancies. However, poor exercise knowledge may contribute to problems or barriers that reduce a woman's level of exercise after becoming pregnant.

Aim: This study was performed to identify pregnancy exercise knowledge among pregnant women using latent class analysis and to examine the relationship between pregnancy exercise knowledge patterns and sociodemographic characteristics.

Design: A descriptive, cross-sectional approach was used in this study.

Methods: Participants were recruited from the prenatal outpatient departments of two hospitals and a certified prenatal center in Taipei, Taiwan. A total of 618 participants completed a pregnancy exercise knowledge test. The data were analyzed using WINMIRA and SPSS 20.0 software.

Results: Two latent classes were identified based on exercise knowledge among pregnant women. The *Accurate Knowledge* group (n = 543, 87.9%), which had a higher latent trait for exercise knowledge (M = 1.31, SD = 0.94), was larger than the *Limited Knowledge* group (n = 75, 12.1%), which had a lower latent trait (M = −0.22, SD = 1.14). The principles of exercise for pregnant women, particularly the appropriate intensity and duration, may be difficult items for women in the *Limited Knowledge* group to understand. Women with *Limited Knowledge* had significantly lower education levels and greater rates of unemployment, multiparity, and miscarriage than women in the *Accurate Knowledge* group.

Linking Evidence to Action: A two-class system for interpreting exercise knowledge among pregnant women is statistically supported. We believe that this study has evidence-based potential to help healthcare providers improve pregnant women's exercise knowledge as part of routine prenatal care to promote exercise.

INTRODUCTION

Exercising throughout pregnancy can improve or maintain physical fitness (American College of Obstetrics & Gynecology [ACOG], 2015), help with weight management (ACOG, 2015; Vargas-Terrones et al., 2019), prevent and treat pelvic and lower back pain (Davenport et al., 2019), and enhance psychological well-being (ACOG, 2015; Liu et al., 2019). Regular exercise during pregnancy has also been shown to decrease the duration of the first phase of labor and the total duration of labor (Barakat et al., 2018) and to lower the risk of induced labor (Ferreira et al., 2019). The ACOG (2015) has provided certain guidelines suggesting that pregnant women with no medical or obstetric complications should continue to exercise and preferably engage in moderate-intensity aerobic activity for at least 20–30 minutes daily or 150 minutes per week.

Previous studies have shown that compared to prepregnancy, pregnant women often exercise less frequently (Lee, Hwang et al., 2016; Nascimento et al., 2015; Tung et al., 2014). In addition, women reported receiving little or no advice about exercise from their obstetric provider (Alvis et al., 2019). Pregnant women are not only unaware of the benefits of exercise during the perinatal period, but many women also believe that exercise is not safe (Ferrari et al., 2013; Lee, Chiang et al., 2016). Therefore, inadequate exercise knowledge may be a barrier to exercise for pregnant women (Petrov Fieril et al., 2014).

Previous studies have shown that pregnant women who visit their obstetrics/gynecology provider are unlikely to obtain exercise knowledge as a routine part of their prenatal care (Basu et al., 2014; Yamamoto et al., 2014). Indeed, pregnant women commonly report that advice regarding

exercise during pregnancy is generally vague (not individualized), constantly changing, and limited to recommendations such as simply walking more (Ferrari et al., 2013). Furthermore, according to Whitaker et al. (2016), 36% of pregnant women report that when they mention exercise, their healthcare providers simply recommend continuation of their previous exercise routine. Thus, pregnant women are seldom specifically advised regarding the frequency, duration, and intensity of exercise needed to meet the ACOG recommendations even though such knowledge should be clearly propagated (Bgeginski et al., 2017).

Exercise knowledge is based on exercise behavior. Poor knowledge or a lack of knowledge of exercise guidelines may contribute to problems with or barriers to physical activity (Petrov Fieril et al., 2014). Therefore, assessing knowledge on exercise during pregnancy may help determine whether women will participate in exercise during and after pregnancy. A few studies have surveyed pregnancy exercise knowledge, and among these studies, only a few questions (one or two questions) were used (De Jersey et al., 2013; Mbada et al., 2014; Ribeiro & Milanez, 2011). Moreover, previous studies have incorporated only observed variables in the exercise knowledge scores of pregnant women, and the authors of these studies were unaware of the number of latent classes that have been defined for pregnant women's exercise knowledge.

Latent class analysis (LCA) is a statistical method used to group individuals (cases, units) into classes (categories) of an unobserved (latent) variable on the basis of responses to a set of nominal, ordinal, or continuous observed variables (Porcu & Giambona, 2017). In psychological measurements, latent variables are variables that are not directly observed but are rather inferred from the observed variables. Studies have adopted latent classes to explore dietary patterns related to pregnancy (Sotres-Alvarez et al., 2010). LCA is a type of mixture model (McLachlan et al., 2019) involving person-centered rather than variable-centered analysis (Elhai et al., 2020). Psychometric assessments have indicated that the total score does not reflect the exact latent classes of knowledge of a person. Moreover, pregnant women's exercise knowledge was not fully explored as a latent trait, which is an unobservable ability or characteristic such as intelligence or a capacity for physical exercise. However, latent traits can still be measured using observed behaviors or responses (Wikipedia, 2020).

LCA could identify the number of latent classes of pregnant women's exercise knowledge, and a trade-off between and among pregnant women's abilities, attitudes, and personality traits was noted (Wikipedia, 2020). Moreover, it could examine similarities and differences between and among classes and how such heterogeneity is related to other variables (Elhai et al., 2020). Therefore, LCA could identify the number of latent classes and their homogeneous characteristics.

The aim of this study was to identify latent classes of exercise knowledge among pregnant women using LCA. We also investigated the relationships between the latent classes and the women's sociodemographic characteristics. First, we determined how many latent classes of pregnancy exercise knowledge exist. Second, we identified the parameters associated with item difficulty and the response probability in each class. Third, we compared and analyzed the sociodemographic characteristics of the pregnant women in each class.

METHODS

Design

This study used a descriptive, cross-sectional research design with purposive sampling.

Study Participants and Setting

The study participants were recruited from the prenatal outpatient departments of two hospitals and from a certified prenatal center in Taipei, Taiwan. Our participants were at least 20 years of age, were diagnosed as being pregnant, and had been given the "Mother's Manual." All participants were native Chinese speakers and completed the consent form. The final sample included 618 participants.

Measures

A 13-item multiple choice survey was developed to evaluate the pregnant women's exercise knowledge using the pregnant women's guidelines of the ACOG. The 13 items and three concepts of pregnancy exercise knowledge included the pregnancy exercise FITT principles of frequency, intensity, duration, and pattern (six items), safety guidelines (six items), and benefits (one item). An obstetrician, professor of nursing, two sports professors, and an obstetrical nurse evaluated the exercise knowledge test. After the professionals scored and commented on the questionnaire, the research committee discussed and modified the low-scoring items. The Content Validity Index (CVI) value was 95%–100%.

The pregnancy exercise knowledge test was administered to 50 participants during the pilot study. We analyzed the item difficulty and item discrimination of the exercise knowledge test. The item difficulty indicates the difficulty of each item and has an inverse relationship with the item value; greater item difficulty corresponds to a lower value (Backhoff et al., 2000). The correct ratio was calculated by adding the percentages of correct responses in a high-scoring group (the top 27%) and a low-scoring group (the bottom 27%) and then dividing by 2. The mean difficulty of the items related to exercise knowledge was 0.48 (range 0.12–0.80), reflecting medium difficulty (values ranged between 0.5 and 0.6; Backhoff et al., 2000; Tomak & Bek, 2015).

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Participants with a discrimination measure of the same ability or competence and a high overall test score would have a high probability of being able to answer an item (Backhoff et al., 2000). Item discrimination was calculated as the percentage of correct responses in the high-scoring group (the top 27%) minus the corresponding percentage in the low-scoring group (the bottom 27%). The mean discrimination value of the exercise knowledge items was 0.30 (range 0.05–0.61), and the discrimination values ranged from 0.26–0.35, indicating good discriminatory power (Tomak & Bek, 2015). The pilot study of the pregnancy exercise knowledge test showed moderate difficulty and good discrimination.

The questionnaire collected information regarding the women's sociodemographic characteristics (e.g., age, occupation, education, and prepregnancy body mass index), prepregnancy and pregnancy exercise habits (≥3 times/week), and perinatal characteristics (parity and miscarriage history).

Data Collection

In the consent form, our study was briefly explained, an assurance of confidentiality was provided, and the right to withdraw from the study was explained. The participants, all of whom voluntarily agreed to take part in the study, were given an explanation of the study and then signed the consent form. After the participants completed a questionnaire, we gave them a gift and thanked them for their participation.

Ethical Considerations

This study was approved by the Institutional Review Board of Mackay Memorial Hospital Hospital (No. 104058-F). The consent forms signed by the participants included both a brief description of the study and an explicit assurance of confidentiality.

Data Analysis

LCA is a person-centered, model-based approach used to identify mutually exclusive classes from a baseline study population based on response patterns, where the numbers and structures of classes are unknown a priori (Collins & Lanza, 2010). The analysis was organized around specific aims. LCA identified the number of different classes of pregnancy-related exercise knowledge, and then, the parameters of the latent class were estimated. WINMIRA 2001 software was used to analyze the data in the latent class (Von Davier, 2001), and SPSS 20.0 was used to examine the sociodemographic characteristics of the pregnant women in each class.

Aim 1: To Identify the Number of Existing Classes of Pregnancy Exercise Knowledge

LCA was used to discover underlying response patterns, thus allowing the identification of respondent groups with similar pregnancy exercise knowledge using WINMIRA software. The number of classes was unknown, and competing models were selected based on the information criteria. Selection of the best-fitting parsimonious models was based on two main criteria: minimizing the Bayesian information criterion (BIC) and achieving a consistent Akaike information criterion (CAIC) to assess the LCA (Collins & Lanza, 2010). Smaller values indicate better fit.

Aim 2: To Assess the Parameters Associated With Item Difficulty and the Response Probability in Each Class

We identified the parameters of item difficulty and the response probability in each class. The Q-index (ZQ) denotes the fit of an item with regard to the conditional probability of its observed item response pattern. ZQ measures the relationship between the items and the latent classes and shows the goodness of fit. ZQ is the standardized Q-index, and 1.96 is an acceptable boundary of item fit (Rost & Von Davier, 1994).

Item difficulty refers to the level of knowledge needed to correctly answer an item. The difficulty estimate within each class was unique and revealed the item characteristics. A higher difficulty estimate indicates a considerably more difficult item for the participants and that a higher knowledge level is required to correctly answer an item in a given latent class. The response probability refers to the likelihood of participants providing the correct response to an item in each latent class. A higher response probability estimate indicates a higher likelihood of participants providing the correct response to an exercise knowledge item. Our study used the following cutoff values: A value greater than 0.8 indicated a high response probability, and a value below 0.5 indicated a low response probability.

Aim 3: To Examine the Relationships Between Different Exercise Knowledge Patterns and the Sociodemographic Characteristics of Pregnant Women

We compared and analyzed the sociodemographic characteristics of the pregnant women in each class as well as their total scores. The statistical analyses were performed using SPSS 20.0 (IBM, Armonk, NY, USA). In particular, frequencies and percentages were used to describe the individual variables, and the mean (*M*) and standard deviation (*SD*) were used to describe the continuous variables. The participants' individual variables were compared using chi-square tests, independent *t*-tests, and ANOVA.

RESULTS

Model Fitting and Latent Classes

The 13 items of the multiple choice pregnancy exercise knowledge test were entered into the model. A two-class

Table 1. Information Criteria for Model Selection

Model	BIC	CAIC
Two-class	5,118.65	5,137.65
Three-class	5,168.43	5,197.43
Four-class	5,216.57	5,255.57
Five-class	5,269.48	5,318.48

Note. BIC = Bayesian information criterion; CAIC = consistent Akaike information criterion.

structure with eight items was the best-fitting model and was selected to describe patterns of pregnant women's exercise knowledge according to the LCA criteria (Table 1).

The eight items and three concepts of pregnancy exercise knowledge included pregnancy exercise FITT principles (five items), safety guidelines (two items), and benefits (one item). The pattern of the difficulty estimates differed within the two classes by the item statistics as shown in Table 2. The standard error was small, and the parameter estimation was acceptable. The fit of these eight items was also assessed within each class based on the Q-index (ZQ). All ZQ values were within the boundary of 1.96, indicating that these items fit well in both classes (Table 2).

Item Analysis in the Latent Classes

Each individual was assigned to the latent class belonging to the highest probability. Figure 1 shows the response probability for items with respect to the two classes in Table 2. For the mean value and standard deviation of pregnant women's latent trait for exercise knowledge, most participants were in Class I ($n = 543$, 87.9%), which had a higher mean value ($M = 1.31$) and a lower standard deviation ($SD = 0.94$) for the latent trait of exercise knowledge. This class was labeled the *Accurate Knowledge* group. Class II ($n = 75$, 12.1%) had a lower mean value ($M = -0.22$) and a higher standard deviation ($SD = 1.14$) for the latent trait of exercise knowledge and was labeled the *Limited Knowledge* group.

Women in the *Accurate Knowledge* group tended to have more items with higher response probabilities (Table 2 and Figure 1) and lower item difficulty estimates (Table 2 and Figure 2) than women in the *Limited Knowledge* group. The concept of exercise FITT principles, including the appropriate type, duration, and intensity of pregnancy exercise, warning signs or symptoms to discontinue exercise, and the benefits of exercise during pregnancy, exhibited a higher response probability in the *Accurate Knowledge* group than in the *Limited Knowledge* group. However, this group had a lower response probability and higher item difficulty for exercise principles addressing the appropriate intensity while exercising during pregnancy.

As shown in Table 2, women in the *Limited Knowledge* group had a lower response probability and higher difficulty estimates than those in the *Accurate Knowledge* group for items 3 and 5; these items assessed the exercise principles reflecting the appropriate duration and intensity of exercise during pregnancy.

Characteristics of the Participants among the Classes

The mean age of the participants was 31 years (31.83; $SD = 14.17$), and the mean gestational age was 28 weeks (28.18; $SD = 6.83$). More than two-thirds of the women were older than 30 years.

Highly educated women and those who were employed, nulliparous, and had no miscarriage history ($p < .05$) had an increased probability of belonging to the *Accurate Knowledge* group. The results did not show any influence of age, prepregnancy or pregnancy exercise habits, or prepregnancy BMI ($p > .05$) on women's knowledge levels (Table 3).

According to Table 4, only the education variable was significantly associated with total scores. In contrast, the variables age, occupation, exercise before pregnancy, exercise during pregnancy, miscarriage history, and parity were not significantly associated with total scores ($p > .05$).

DISCUSSION

A two-class structure was selected when conducting the LCA for exercise knowledge among pregnant women in Taiwan. Most participants were in the *Accurate Knowledge* group, which had greater exercise knowledge than the *Limited Knowledge* group. The *Limited Knowledge* group included a smaller proportion of pregnant women, and women in this group had less exercise knowledge, a significantly lower educational level, and higher rates of unemployment, multiparity, and miscarriage than the women in the *Accurate Knowledge* group. Healthcare providers and exercise professionals should be reminded to promote exercise knowledge among pregnant women in the *Limited Knowledge* group. Moreover, the exercise principles regarding the appropriate duration and intensity in terms of heart rate of pregnancy exercise had a lower response probability and higher estimated item difficulty in the *Limited Knowledge* group than in the *Accurate Knowledge* group.

Previous studies have found that higher education levels were associated with knowledge regarding exercise during pregnancy, which is consistent with our study (Mbada et al., 2014; Ribeiro & Milanez, 2011). The reason for this result may be that higher educational attainment is significantly associated with patients who may more easily understand or apply pregnancy exercise knowledge and have adequate health literacy (Chen, Huang, Yang, & Lew-Ting, 2014).

However, lower education levels were clearly linked to poorer physical and mental health among women (Chazelle

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Table 2. Item Statistics and Response Probability for the Two Classes

Concepts	Items	Accurate Knowledge (n = 543)				Limited Knowledge (n = 75)			
		Difficulty estimate	Standard error	Q-index (ZQ)	Response probability	Difficulty estimate	Standard error	Q-index (ZQ)	Response probability
1. Principles									
(1) **Type** Which sport is appropriate for women during pregnancy? A. basketball, B. swimming, C. diving, D. unknown	1	−0.99	0.16	−0.31	.90*	−1.09	0.29	0.17	.77
(2) **Frequency** Which is an appropriate exercise frequency for pregnant women who were regular exercisers before pregnancy? A. Similar to prepregnancy, B. higher than prepregnancy, C. not restricted, D. unknown	2	1.07	0.01	0.1097	.55	−1.01	0.29	−0.22	.76
(3) **Duration** Which is an appropriate exercise duration for previously active pregnant women? A. Below 10 min, B. more than 20–30 min, C. longer is better, D. unknown	3	−1.05	0.16	−0.20	.90*	1.63	0.32	1.54	.34+
(4) **Intensity** How many heartbeats per minute during exercise is appropriate for pregnant women? A. < 100 beats/minute, B. 130–150 beats/minute, C. > 180 beats/minute, D. unknown	5	1.77	0.10	1.11	.38+	4.37	0.70	0.41	.10+
(5) **Cooling down and warming up** For the prevention of injuries during exercise, at least how much cooldown and warmup time are necessary for pregnant women? A. 5–10 min, B. 15–20 min, C. > 30 min, D. unknown	6	1.09	0.10	−0.05	.54	−0.14	0.27	−0.32	.62
2. Safety guidelines									
(1) **Gradually increasing exercise level** Which safety guidelines for exercise level are appropriate for exercise during pregnancy? A. gradually increase, B. gradually decrease, C. exercise is unnecessary, D. unknown	4	−1.49	0.19	0.06	.94*	−1.72	0.33	0.10	.85*
(2) **Signs or symptoms to discontinue or stop exercise** Which warning signs or symptoms should lead to discontinuing or stopping exercise while pregnant? A. vaginal bleeding, B. chest pain and muscle weakness, C. appearance of uterine contractions or a decrease in fetal movement, D. heartbeat or blood pressure continue to increase after exercise. (A. AB, B. CD, C. ABC, D. ABCD, E. unknown)	7	−0.25	0.12	−0.41	.82*	−1.64	0.32	−0.02	.84*
3. Benefits									
(1) **Reducing the risk of gestational diabetes** Which is a benefit of pregnancy exercise? A. reduce the risk of fetal malformation, B. reduce the risk of gestational diabetes, C. reduce the risk of headache, D. unknown	8	−0.20	0.12	−0.26	.81*	−0.40	0.27	−0.76	.66

Note. *Response probability > 0.8; + Response probability < 0.5.
The correct answer to each question is underlined.

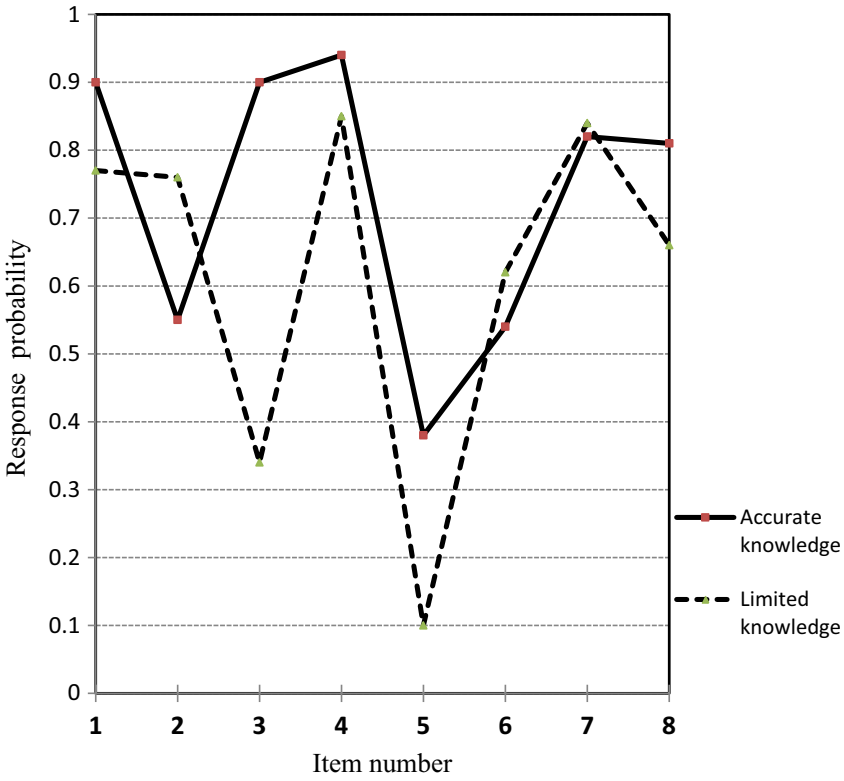

Figure 1. Response probability of items for the Accurate Knowledge and Limited Knowledge.

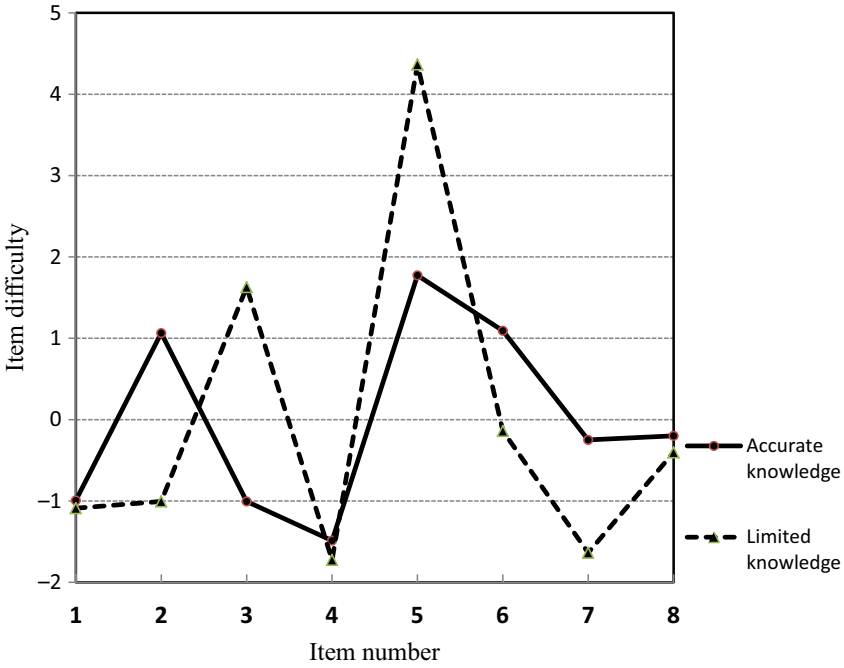

Figure 2. Item difficulty estimates for the Accurate Knowledge and Limited Knowledge.

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Table 3. Characteristics of Women in the Two Classes (*N* = 618)

	Latent class		
	Accurate Knowledge (n = 543)	**Limited Knowledge (n = 75)**	
Variables	**(%)**	***N* (%)**	**Chi-squared**
Age			2.025
20–29	164 (30.2)	22 (29.3)	
30–32	184 (33.9)	27 (36.0)	
33–35	125 (23.0)	13 (17.3)	
36–44	70 (12.9)	13 (17.3)	
Occupation			3.31*
Unemployed	181 (33.3)	33 (44.0)	
Employed	362 (66.7)	42 (56.0)	
Education level			23.81***
Below junior high school	70 (12.89)	26 (34.67)	
Above college or university	473 (87.11)	49 (65.33)	
Exercise before pregnancy (>3 times/week)			0.22
Yes	196 (36.10)	25 (33.33)	
No	347 (63.90)	50 (66.67)	
Exercise during pregnancy (>3 times/week)			2.48
Yes	195 (35.91)	20 (26.67)	
No	348 (64.09)	55 (73.33)	
Miscarriage history			7.77**
Yes	105 (19.34)	25 (33.33)	
No	438 (80.66)	50 (66.67)	
Parity			18.19***
Nulliparous	368 (67.78)	32 (42.67)	
Multiparous	175 (32.22)	43 (57.33)	
Variables	**Mean (*SD*)**		***t*-value**
Prepregnancy BMI	21.14 (2.87)	21.37 (3.05)	−0.65
Age	31.79 (3.74)	32.10 (3.95)	−0.68

Note. *$p < .05$; **$p < .01$; and ***$p < .001$.

et al., 2011; Tooth & Mishra, 2015). The reason for this association may be as follows: The higher proportion of miscarriage history in the *Limited Knowledge* group, which included women who may have had a history of miscarriages or inadequate exercise knowledge during a previous pregnancy regarding possible causes of miscarriage, created a fear that exercise could cause another miscarriage. Previous studies have shown that more past pregnancies and a history of miscarriage were significantly associated with less exercise (Lee, Hwang, et al., 2016; Nascimento et al., 2015; Ribeiro & Milanez, 2011; Tung et al., 2014).

The FITT principles of exercise, particularly the appropriate intensity and duration, may be difficult for and unfamiliar to pregnant women in the *Limited Knowledge* group. Previous studies have shown that pregnant women are concerned that too much exercise could harm the pregnancy and hurt them or the growing baby, and that they lack knowledge regarding the types and amounts of exercise

Table 4. Characteristics of Women in the Total Scores (*N* = 618)

Variables	*N* (%)	Mean (*SD*)	*t/F*
Age			.976
20–29	186 (30.1)	5.58 (1.47)	
30–32	211 (34.1)	5.74 (1.23)	
33–35	138 (22.3)	5.82 (1.38)	
36–44	83 (13.4)	5.64 (1.28)	
Occupation			–1.59
Unemployed	214 (34.6)	5.58 (1.45)	
Employed	404 (65.4)	5.76 (1.29)	
Education level			–5.04***
Below junior high school	96 (15.53)	5.07 (1.62)	
Above college or university	522 (84.47)	5.81 (1.26)	
Exercise before pregnancy (> three times/ week)			–.801
Yes	221 (35.76)	5.67 (1.35)	
No	397 (64.24)	5.76 (1.35)	
Exercise during pregnancy (> three times/ week)			–1.20
Yes	215 (34.79)	5.65 (1.37)	
No	403 (65.21)	5.79 (1.31)	
Miscarriage history			–.27
Yes	130 (21.04)	5.67 (1.36)	
No	488 (78.96)	5.71 (1.35)	
Parity			–1.82
Nulliparous	400 (64.72)	5.77 (1.34)	
Multiparous	218 (35.28)	5.56 (1.36)	

Note. *$p < .05$, **$p < .01$, and ***$p < .001$.

that are safe (Krans & Chang, 2012; Muzigaba et al., 2014). The fear is that "overdoing it" while exercising could cause a miscarriage (Ferrari et al., 2013).

Health providers focusing on obstetric check-ups seldom provide specific advice regarding the exercise principles meeting the ACOG recommendations (Alvis et al., 2019) even though such knowledge should clearly be provided (Bgeginski et al., 2017). Social relationships can affect the thoughts and knowledge of individuals (Robinson & Henderson, 2018). Furthermore, when health providers educate pregnant women about exercise, they should recognize that knowledge beliefs are primarily based on societal contexts.

Traditional Taiwanese individuals believe that pregnant women should avoid exercise as much as possible to prevent miscarriage (Lee, Chiang, et al., 2016). A primary concern regarding exercise among pregnant Taiwanese women is the safety of the mother and baby. If women exercise during pregnancy, they should know about the exercise principles and advantages, which may give these women the confidence to prevent the risks of exercise during pregnancy. The lower response probability of the more difficult concepts of pregnancy exercise principles should serve as a reminder to healthcare providers to educate pregnant women.

If a person's social beliefs include the belief that exercise during pregnancy is dangerous and unhealthy for pregnant women (Lee, Hwang, et al., 2016), health providers must thoroughly understand the "why" and "what" underlying pregnancy exercise knowledge. Therefore, health providers must not only provide pregnancy exercise knowledge to pregnant women but also understand their beliefs regarding exercise during pregnancy to ensure that pregnant women understand that exercising correctly can promote maternal health with no harm to the fetus.

Moreover, multiparous women may lack the time to become educated about exercise during pregnancy or may decrease the time spent exercising due to family responsibilities with children in the household (Muzigaba et al., 2014; Nascimento et al., 2015). Currently, caring for children may be a barrier to exercise among women; thus, the availability of child care may be involved in these associations. The *Limited Knowledge* group may fear having a miscarriage or lack child care, both of which can influence exercise during pregnancy. Providing knowledge regarding how to exercise to caregiving multiparous women to increase their interest may result in increased exercise knowledge and practice, which can be accomplished by initiating antenatal exercise education and exercise sessions during antenatal visits or establishing community-based group exercise clubs (Abiodun et al., 2014) to educate women on how to take their children along and exercise together during pregnancy.

The LCA model was the main quantitative methodology used in this study. Previous studies have applied this quantitative methodology to identify body composition patterns, knowledge, and attitudes toward antibiotic use and resistance (Vallin et al., 2016; Zhang et al., 2019). To the best of our knowledge, this study is the first to use LCA to analyze

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exercise knowledge among pregnant women. Our findings strongly suggest that grouping according to the LCA model is effective for more fully understanding pregnant women's exercise knowledge and the relatively homogeneous groups underlying different levels of exercise knowledge. The percentage of correct answers is used in traditional knowledge tests, but this parameter did not relate to the knowledge traits of pregnant women. Notably, the LCA in our study identified the following two classes: a group with a high response probability and a group with a low response probability. This LCA may help clinicians identify differences in characteristics or potential problems with exercise knowledge between the two classes of women. However, traditional knowledge tests may divide the participants into two or three groups based on their scores (high and low scores or high, medium, and low scores, respectively). Women with higher scores on the exercise knowledge part of the test may not have more exercise knowledge, just as women with low scores on this part of the test may not necessarily have less exercise knowledge. Based on the eight-item exercise knowledge test, the discrepancy between the latent groups and the characteristics of each group was easily identified. Therefore, LCA may help clinicians identify the latent groups' homogeneous characteristics or traits. This analysis may also help clinicians easily identify women in each group by characteristics or help them design an educational program to solve the knowledge problems of different groups. Women in the two groups have different pre-existing levels of exercise knowledge. Clinicians can use a knowledge test to more easily distinguish between the two groups and to more effectively provide the best educational programs for the different groups and thus enhance their exercise knowledge.

Our study has several limitations. The participants were selected from North Taiwan and were older and had a higher educational level; therefore, the results cannot be generalized to all pregnant women. In the future, we could perform a survey by randomized sampling or conduct a longitudinal study to follow the exercise practices or maternal/birth outcomes of pregnant women. Such a study may provide an understanding of how difficulty related to exercise knowledge influences exercise behaviors or maternal/birth outcomes.

CONCLUSION

We identified two groups of exercise knowledge among pregnant women. Most pregnant women were in the *Accurate Knowledge* (87.9%) group, while only 12.1% of the women were in the *Limited Knowledge* group. Educational level, occupation, miscarriage history, and parity differed significantly between the groups. The safety guidelines for exercise are not difficult concepts and had high response probabilities in both groups. However, the concepts of the exercise principles, particularly the appropriate intensity and duration, may be difficult and unfamiliar for women of the *Limited Knowledge* group. Social relationships affect pregnant women's thoughts and knowledge concerning exercise during pregnancy. Healthcare providers should recognize their patients' beliefs and knowledge regarding pregnancy exercise based on their societal contexts. In addition, healthcare providers must understand the "why" and "what" of pregnancy exercise concepts to assist pregnant women in attaining *Accurate Knowledge* on exercise. LCA is a useful person-centered analytical approach for identifying patterns of pregnancy exercise knowledge and can be used to develop personalized interventions to educate pregnant women about exercise.

LINKING EVIDENCE TO ACTION

- Two latent classes, *Accurate Knowledge* and *Limited Knowledge*, were identified based on exercise knowledge among pregnant women.
- Most pregnant women were classified as having *Accurate Knowledge* (87.9%); only 12.1% of the women had *Limited Knowledge*.
- Women with *Limited Knowledge* had significantly lower education levels and higher rates of unemployment, multiparity, and miscarriage than those with *Accurate Knowledge*.
- The concepts of exercise principles, particularly the appropriate intensity and duration, may be difficult for women in the *Limited Knowledge* group to understand.
- Healthcare providers should recognize women's beliefs regarding exercise during pregnancy based on the societal context.

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