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The Relationship of Nutrition Knowledge, Nutrition Attitude, and Physical Activity with Biomotor Abilities and Body Mass Index among Female Adolescent Students

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ABSTRACT

Background: Better understanding of adolescents' nutrition knowledge, nutrition attitude, and physical activity seems to help develop more effective interventions to promote their health. The aim of this study was to assess the relationship of nutrition knowledge and attitude, and physical activity with biomotor abilities and body mass index (BMI) among female adolescent students.

Methods: In a descriptive-correlational field study conducted from March to June 2023 in Marand, Iran, 325 female adolescent students aged 15-18-year-old were enrolled through a multi-stage sampling method. Data were collected using demographic, nutritional knowledge, nutrition attitude, and Baecke habitual physical activity questionnaires. The sit and reach flexibility, Plank, and YMCA 3-minute step tests were also undertaken.

Results: Nutrition knowledge had significant correlation with biomotor abilities and physical activity, while nutrition attitude showed significant correlation with BMI.

Conclusion: Evidence-based health behavior change techniques are suggested to improve biomotor abilities and physical activity and to maintain BMI within normal range.

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Introduction

The increasing prevalence of unhealthy eating among adolescents, with a current prevalence of 70%, is still a major public health challenge (1). The findings of a study revealed that adolescents consumed at least once high-calorie, low-nutrient, high-salt, or high-sugar food per week (2). Unhealthy eating and limited physical activity in adolescence were demonstrated to increase the risks of obesity (3), cardiovascular diseases (4), type 2 diabetes mellitus (5), cancer (6), and cognitive alterations (7) in adulthood. Lack of knowledge about healthy eating and limited physical activity among female adolescents were shown to be more common than their male counterparts (8).

Nutrition knowledge is considered as one of the most important determinants of eating habits (9), as adequate nutrition knowledge can positively

influence the ability to determine healthy foods and manage non-communicable chronic diseases (10) and thereby, can reduce the prevalence and the burden of these diseases (11). However, adequate nutrition knowledge is not enough for behavior modification; because factors such as culture, beliefs, and attitudes can also influence the behavior. Therefore, improvement of both nutrition knowledge and attitude is necessary for modification of nutritional behavior (12, 13).

Physical activity can also influence health-related outcomes among adolescents. Limited physical activity together with unhealthy eating due to poor nutrition knowledge and attitude were found to negatively affect health status (12, 14) and to increase the risk of obesity and its associated disorders among adolescent population. On the other hand, regular physical activity can positively affect energy consumption, weight, and body mass index (BMI) (15-17) and reduce the risks of obesity, cardiovascular diseases, type 2 diabetes mellitus, and hypertension. Nonetheless, the estimates of the Center for Disease Control and Prevention showed that only 20% of adults in the United States performed adequate aerobic physical activity (18). Therefore, the World Health Organization has set the goal of reducing immobility by 15% by 2030 (19).

Physical activity and healthy eating are usually coincident behaviors and influence each other. A study in Malaysia revealed that most adolescents had unhealthy eating habits and a limited physical activity (20). Another cross-sectional study on 102072 adolescents also showed that almost one fourth of these adolescents had unhealthy lifestyle behaviors such as unhealthy eating and limited physical activity (21). Moreover, another study illustrated the gaps in adolescents' knowledge on nutrition and physical activity and noted that half of them did not fulfill their physical activity-related needs (22). It was also shown that positive energy balance due to excessive calorie intake or limited physical activity can lead to obesity and can alter biomotor abilities (12). Despite the wealth of studies into the eating habits and physical activity of adolescents, there are limited information about the relationship of the nutrition knowledge and attitude, and physical activity with the BMI. Therefore, the present study was designed and conducted to provide evidence in this area and to assess the relationship of nutrition knowledge and attitude, and physical activity with biomotor abilities and BMI among female adolescent students.

Materials and Methods

This descriptive-correlational field study was conducted from March to June 2023 and enrolled female adolescent students of 15-18-year-old through a multi-stage sampling method from girls' high schools in Marand, Iran. Initially, eight high schools were randomly selected and then, three classes were randomly included from each high school and finally, twenty students were randomly enrolled from each class. Accordingly, 480 students were recruited to the study. Inclusion criteria were good self-report physical health status and no affliction by serious physical or psychological problems. Sample size was finally determined to be 325 using the Cochran formula with a response rate of 50% and a confidence level of 0.95 (12).

A 31-item nutrition knowledge questionnaire, namely nutrition knowledge (eleven items), nutrition attitude (eleven items), and eating style (nine items) was employed. Correct answers to the items of the first and the second parts were scored 1 and the items of the third part were scored 0-3. The total score of the questionnaire was calculated through summing the scores as follows: Scores less than 50 were considered a poor nutrition knowledge, scores of 50-65 were defined as a moderate nutrition knowledge; and scores of 65 and more were regarded a good nutrition knowledge (23, 24). The questionnaire was translated into Persian and culturally adapted for the context of Iran based on the comments of the nutritionists of Tabriz University of Medical Sciences, Tabriz, Iran, who confirmed its acceptable validity. The Cronbach's alpha of the questionnaire was 0.80, which confirmed its acceptable reliability.

Nutrition attitude questionnaire with ten items was scored on a five-point scale from 1 ("Completely disagree") to 5 ("Completely agree"). The sum score of the items was divided by the total number of the items to calculate the total score of the questionnaire which was interpreted as follows: Score less than 3.5 was described as a poor nutrition attitude; and scores of 3.5 and more were indicated as a good nutrition attitude (25). Ten faculty members of Tabriz University of Medical Sciences, Tabriz, Iran, assessed and confirmed the validity of this questionnaire. Its content validity index and Cronbach's alpha were 0.96 and 0.88, respectively.

A Baecke Habitual physical activity questionnaire with sixteen items in three subscales, namely occupational (eight items), sport (four items), and recreational (four items) subscales was utilized (26). A study reported the acceptable validity of this questionnaire with Cronbach's alpha values of 0.74-0.88 (27). Several academic specialists also assessed and confirmed the validity of the questionnaire in the present study. To determine BMI, two physical training experts measured participants' weight and

height. Weight was measured with the minimum possible clothes and no shoes using a weight scale with a precision of 0.1 kg (Seca, Germany). Height was also assessed in standing position without shoes applying a stadiometer with a precision of 0.1 cm. Then, BMI was calculated through dividing weight (kg) by the square of height (m).

The biomotor abilities were evaluated, while most body movements included at least one biomotor ability, namely strength, flexibility, and cardiopulmonary fitness (28). The sit and reach flexibility test was undertaken after a short warm up exercise, while participants sat on the ground without shoes with straight knees, and their soles (with a distance of 25-30 cm from each other) faced a box with a height of 30 cm. A measurement tape was placed on the box parallel to participants' legs, when participants put their hands over each other and attempted to bend their back as much as possible over the box without bending their knees. Each of them had three attempts and the best performance was documented as the test score. The quality of stretching was also examined through measuring the curve of the spinal column and the hip angle. The scores of this test was interpreted as follows: More than 34 cm for men and more than 37 cm for women were demonstrated well above average; 28-34 cm for men and 33-36 cm for women were illustrated above average; 23-27 cm for men and 29-32 cm for women were shown average; 16-22 cm for men and 23-28 cm for women were displayed below average; and less than 16 cm for men and less than 23 cm for women were exhibited well below average (29).

To conduct the prone forearm plank test, participants maintained elevated position through putting the elbow, the forearm, and the toe tips on the ground, elevating the hip, and keeping a straight head-to-toe horizontal alignment. Participants' head was face-down during the test without looking forward. Chronometer was started as soon as each participant assumed the proper alignment and was stopped when he/she could not further maintain the proper alignment. This test was interpreted as follows: More than six minutes was recorded excellent; 4-6 minutes was considered very good; 2-4 minutes was defined above average; 1-2 minutes was described average; 30-60 seconds was mentioned below the average; 15-30 seconds was pointed poor; and less than fifteen minutes was represented very poor (30).

YMCA 3-minute step test was used to assess cardiopulmonary endurance or fitness. Participants stepped on and down a stair with a height of thirty cm and with a rate of 22 times (or 88 steps) per minute for women and 24 times (or 96 steps) for men. Five seconds after performing the test for three minutes, a stethoscope was applied to count the heart rate for one minute. The number of heart beats per minute was considered as the test score and was interpreted using the YMCA table (31).

Table 1: Participants' demographic characteristics, BMI, and biomotor abilities.

Variable			Relative frequency	Absolute frequency	Mean±SD	
Age (Years)			—	325	17.05±0.96	
Height (cm)			—	325	163.93±5.83	
Weight (kg)			—	325	56.79±9.96	
Body mass index (kg/m^2)	<18.5 (Underweight)		25.8	84	21.12±3.44	
	18.5-24 (Normal)		62.2	202		
	25-29.9 (Overweight)		11.4	37		
	≥30 (Obese)		0.6	2		
Biomotor abilities	Flexibility	41	16.3	53	7.34±34.31	18.72±150.00
		37-40	21.5	70		
		33-36	20.3	66		
		28-32	24.6	80		
		≥27	17.2	56		
	Step test	52-81	1.2	4	20.21±123.67	
		82-102	17.8	58		
		103-110	8	26		
		111-120	22.2	72		
		121-131	11.4	37		
		132-169	39.4	128		
	Plank test	<63 seconds	43.7	142	21.28±62.63	
		63-79 seconds	30.5	99		
		80-90 seconds	23.7	77		
		91-120 seconds	2.2	7		
		≥121	0	0		

The third, fourth, and fifth authors completed the questionnaires for each participant using the face-to-face interview method. A pilot study was conducted on thirty students at all schools other than the study setting in order to pilot the questionnaires and identify and correct any possible error in data collection. In total, 325 sets of questionnaires were completed for 325 participants and were included in the final analysis. Data were analyzed at a significance level of less than 0.05 using the SPSS software (version 21.0, Chicago, IL, USA). Normality was tested using the Shapiro-Wilk test and correlations were analyzed using Spearman's correlation analysis. Data were described via absolute and relative frequencies for categorical variables and mean and standard deviation (Mean±SD) for numerical variables.

Results

The mean of participants' age, weight, height, and BMI were 17.05±0.96 years, 56.79±9.96 kg, 163.93±5.83 cm, and 21.12±3.44 kg/m^2, respectively. Most participants had normal BMI (62.2%) and only 0.6% had a BMI of more than 30. The mean score of biomotor abilities was 150.00±18.72 in total, 34.31±7.34 for the flexibility test, 123.67±20.21 for the step test, and 62.63±21.28 for the plank test (Table 1). The mean scores of nutrition knowledge and nutrition attitude were 58.97±8.69 and 3.18±0.44, respectively and the mean scores of the sport, recreational, and occupational subscales of the habitual physical activity were 2.67±0.65, 2.56±0.71, and 2.61±0.55, respectively. Most participants had good nutrition knowledge (57.5%) and good nutrition attitude (61.8%), while only 3.4% of them had good physical activity (Table 2).

The results of correlation analysis revealed that nutrition knowledge had significant correlation with nutrition attitude, biomotor abilities, and physical activity, while nutrition attitude had significant correlation with nutrition knowledge and BMI. However, there was no significant correlation between nutrition knowledge and BMI, nutrition attitude and biomotor abilities, nutrition attitude and physical activity, physical activity and biomotor abilities, and physical activity and BMI (Table 3).

Discussion

This study assessed the relationship of nutrition knowledge and attitude, and physical activity with biomotor abilities and BMI among female adolescent students. Participants had moderate nutrition knowledge. Moreover, although there were no significant relationships between nutrition knowledge and

Table 2: Participants' nutrition knowledge, nutrition attitude, and habitual physical activity.

Variable			Absolute frequency	Relative frequency	Mean±SD
Nutrition knowledge		>50% (Poor)	12	39	58.97±8.69
		50%-64% (Good)	57.5	187	
		≥65% (Excellent)	30.5	99	
Nutrition attitude		1-2.33 (Poor)	1	0.3	3.18±0.44
		2.34–6.67 (Good)	123	37.8	
		3.68-5 (Excellent)	201	61.8	
Habitual physical activity	Sport	1-2.33 (Poor)	32	104	2.67±0.65
		2.34-3.67 (Good)	59.7	194	
		3.68-5 (Excellent)	8.3	27	
	Recreational	1-2.33 (Poor)	44.6	145	2.56±0.71
		2.34-3.67 (Good)	48	156	
		3.68-5 (Excellent)	7.4	24	
	Occupational	1–2.33 (Poor)	28	91	2.61±0.55
		2.34-3.67 (Good)	68.6	223	
		3.68-5 (Excellent)	3.4	11	

Table 3: Pairwise correlations among the study variables.

Variable	X1	X2	X3	X4	X5
Nutrition knowledge (X1)	1				
Nutrition attitude (X2)	0.163**	1			
Biomotor abilities (X3)	0.125*	047/0	1		
Body mass index (X4)	-0.068	*115/0-	062/0-	1	
Physical activity (X5)	0.119*	091/0	075/0	034/0-	1

*Significant correlation at a level of less than 0.05, **Significant correlation at a level of less than 0.01.

BMI, between nutrition attitude and physical activity, and between nutrition attitude and biomotor skills, nutrition knowledge had significant relationship with biomotor abilities and physical activity, and nutrition attitude had significant relationship with BMI. These findings are in line with the findings of two previous studies (32, 33). A study on semiprofessional soccer players showed that nutrition education may improve nutritional choices and the different components of physical activity including flexibility, strengths, and cardiopulmonary fitness (33). These findings denote the importance of nutrition knowledge and nutrition attitude for biomotor abilities. Good nutrition knowledge and attitude may lead to healthier nutritional choices, and ensuring the intake of essential macro- and micro-nutrients.

Our findings showed no significant relationship between nutrition knowledge and BMI which is in agreement with the findings of two previous studies (34, 35). The insignificant relationship between nutrition knowledge and BMI in the present study may be due to several factors. First, the effects of nutrition knowledge on BMI may be influenced by other variables such as the level of physical activity and socioeconomic status. For example, greater engagement in physical activity may reduce the effects of nutrition knowledge on BMI. Second, factors with potential effects on BMI, like genetic, mental, and environmental factors were not assessed in the present study and further studies to assess the interrelationships of nutrition knowledge, physical activity, and BMI are recommended (36, 37). Contrary to our findings, a study reported significant positive relationship between nutrition knowledge and BMI (38). Another longitudinal study on university students in China also found significant inverse relationship between nutrition knowledge and BMI so that students with better nutrition knowledge had lower BMI (39).

Study findings also showed that physical activity had no significant relationship with biomotor abilities and BMI. Although participants with more physical activity had greater biomotor abilities than those with less physical activity, and the difference was not statistically significant. Adolescents need to consume extra energy due to their growth spurts. This increased need for energy can put them at risk for unhealthy eating. Therefore, their imbalanced calorie intake may alter their energy balance and cause an abnormal BMI for them despite engagement in regular physical activity. Another explanation for the insignificant relationship of physical activity and BMI in the present study is that higher level of physical activity does not necessarily guarantee lower BMI. Unlike our findings, a study in Ghana reported the significant relationship of physical activity knowledge, nutrition knowledge, and physical activity with BMI (12). Higher BMI is associated with lower flexibility, cardiopulmonary endurance, and strength, while higher level of physical activity is associated with better physical fitness. The relationship of physical fitness and BMI is complex and further studies are necessary for its complete understanding.

We also found significant positive relationship between nutrition knowledge and the level of physical activity. In other words, participants with greater nutrition knowledge tended to have higher level of physical activity. However, the level of physical activity had no significant relationship with nutrition attitude. In agreement with our findings, a study on students found significant relationship between nutrition knowledge and attitude towards physical activity and reported nutrition knowledge as a positive predictor of this attitude (40). Nutrition knowledge is a significant predictor of physical activity habits so that greater nutrition knowledge is associated with higher level of physical activity. This is probably due to the fact that understanding healthy nutrition guidelines leads to informed behaviors and improves the level of physical activity (36, 37).

In overall, some of our findings were not in agreement with the findings of some previous studies. An explanation for this disagreement is the difference among studies respecting their designs, data collection methods, and participants' characteristics (such as age and gender).

This study had some limitations too. One of the limitations was that the population sample consisted of only high school students and therefore, the findings can cautiously be generalized to other students. Moreover, this study was conducted on female students and its findings may be different from studies on male students.

Conclusion

This study concludes that female adolescent students have moderate nutrition knowledge, poor nutrition attitude, and normal BMI, and shows that their nutrition knowledge has significant relationship with their biomotor abilities and physical activity, and their nutrition attitude has significant relationship with their BMI. Therefore, educational programs are recommended to improve their nutrition knowledge and attitude and thereby, to improve their biomotor abilities and physical activity and to maintain their BMI within normal range. The contradiction of some findings of the present study with the findings of previous studies

highlights the importance of more studies to produce clearer evidences in this area.

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Authors' Contribution

All authors have made a direct and intellectual contribution to the work. E.P, M.K designed and conducted intervention wrote the manuscript. Z.M, L.E, and B.E collected date and interpreted data. The first and the second authors interpreted data. The third, fourth and fifth authors revised it for content and edited it grammatically and scientific witting.

Conflict of Interest

None declared.

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