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The Relationship Between Physical Activity and Nutritional Knowledge with Body Mass Index and Motor Proficiency in Girls 10 to 14 Years Old During the COVID-19 Pandemic in Khanaqin

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A B S T R A C T

Introduction: The COVID-19 pandemic allowed us to test the relationship between lifestyle changes and children's motor proficiency level, And by preventing the decrease in movement skills, we should predict the necessary programs to improve the health of children and students during epidemics. The purpose of this research was to investigate the relationship between physical activity and nutritional knowledge with body mass index (BMI) and motor skills of girls aged 10 to 14 years.

Materials & Methods: The research was correlational-descriptive with a cross-sectional way. The statistical population was 350 selected girls aged 10 to 14 years in schools in Khanaqin city, which were randomly selected as the research sample. In this study, the Bruininks Oseretsky test-Short Form (BOT-2), International Physical Activity Questionnaire (IPAQ), and the Eating Habits Questionnaire (EHQ) were used to collect data. Data analysis was carried out using Pearson's correlation coefficient to SPSS V.21 at the $P<0.05$.

Results: Physical activity correlated negatively ($r=-0.29$, $p=0.01$) with BMI and correlated positively with motor proficiency ($r= 0.213$, $p=0.05$), but there is no significant relationship between nutritional knowledge with BMI and motor proficiency of girls aged 10 to 14 years old in the schools of Khanaqin during the Corona era.

Conclusion: Physical activity during the Corona period improves the BMI and motor skills in girls. Therefore, to have a positive effect on motor skills, it is necessary to choose appropriate physical activities according to the situation and perform them regularly.

Keywords: Body Mass Index, COVID-19, Motor Proficiency, Nutritional Status, Sports

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Introduction

In recent years, numerous children have had to remain at home due to the outbreak of the novel coronavirus (1). To curb the transmission of the virus, schools worldwide have been closed due to complete lockdowns since March 2019 (2). All non-essential services and factories were closed, and all kinds of sports and recreational activities were suspended, leading to prolonged restrictions on physical activity in many children's lives worldwide (3).

Previous studies have reported that when children don't go to school for long periods, inactivity and an unhealthy lifestyle affect their health and motor skills (4). Poor diet and lack of physical activity are major risk factors for non-communicable diseases (5). Research has shown that combining physical activity with a healthy diet provides the greatest health benefits and influences overall health throughout life 6).

Lack of physical activity contributes to roughly 3.2 million deaths annually. It is associated with adverse conditions like cardiovascular disease, overweight, insulin resistance, and high blood pressure (7). Physical activity can have a dramatic impact on a person's daily energy expenditure. An imbalance in diet and the level of physical activity affects weight and leads to changes in body mass index (BMI ((8). BMI was calculated by dividing weight (kg) by height (squared meters), and subdivided according World Health Organization (WHO) into four categories: underweight (BMI < 18.5), normal (BMI 18.5–24.9), overweight (BMI 25.0–29.9), and obese (BMI ≥ 30) (9).

Since physical activity habits are established during adolescence and often persist into adulthood, it is important to identify factors that can help increase physical activity levels within society (10).

Because improving the health of adolescent girls can ensure the health of future generations, as they will become future mothers, adolescence is a critical period for implementing intervention programs focused on improving nutrition and general health (11). Numerous studies have shown that abnormal learned eating behaviors are one of the main causes of malnutrition, obesity, or impaired growth and development. Research has shown that cultural beliefs, attitudes, and perceptions have a greater influence on nutritional behaviors than actual nutritional knowledge. Consequently, improving nutritional attitudes is crucial to changing eating habits. (12-14).

Proficiency in motor skills may be a key factor in adolescents' decision to participate in physical activity (15). Motor proficiency refers to different aspects of both gross and fine motor development and serves as an index of children's motor development (16). These skills involve the building blocks for complex and specialized movement skills. They are common movement activities, such as running, balancing, catching, jumping, and throwing that can lead to enhanced physical activities (17). Liu D examined the relationship between fundamental motor skills and physical activity levels and demonstrated a significant correlation between proficiency in fundamental motor skills and physical activity (18).

The rapid increase in the number of COVID-19 cases in Iraq, like many countries, led to non-pharmaceutical interventions to manage and prevent the spread of the disease across the country with more severe restrictions, such as staying at home, banning public events, closing schools and universities, closing restaurants, working from home, limiting sports and outdoor activities. These restrictions severely affected physical activity and nutrition, including the types of food, the number of meals and snacks, the reduction in time spent in physical activities, and changes in the types of physical activities (19).

COVID-19 lockdown gave us a unique opportunity to study children's motor skills development during the pandemic. The purpose of this study is to

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provide information on the relationship between physical activity and nutrition with children's motor skills development during the COVID-19 pandemic in Iraq, to prevent the decline in motor skills, and to prepare appropriate programs to enhance and support children's health during pandemics.

Given the lack of similar studies in Iraq, this study investigated the relationship between physical activity and nutrition knowledge with BMI and motor skills in 10- to 14-year-old female students in Khanaqin, Iraq, during the COVID-19 period.

Materials and methods

Study Design

The research was correlational-descriptive with a cross-sectional way, with data gathered through questionnaire surveys. The statistical population comprises all female students attending schools in Khanaqin, Iraq.

Setting and Participants

The inclusion criteria required participants to be aged 10 to 14 years and free from rare conditions such as cardiovascular disease, hypertension, diabetes, anemia, as well as motor, physical, or mental disorders.

Measurements & Validity and Reliability

1.Demographic tool

M Demographic variables included age, weight, and height, and BMI measurements.

2.International Physical Activity Questionnaire (IPAQ)

E Physical activity was assessed using the IPAQ questionnaire designed for children and adolescents. The short version of this questionnaire, created in 1998 by an international expert group in Geneva, has been validated and proven reliable across 12 countries. The short form of the IPAQ used in the present study (9 items) provide information on time spent walking, in vigorous- and moderate-intensity activity and in sedentary activity during the past seven days. The physical activity score ranges from 1 to 5 points, a score of 1 to 2.33 indicating low activity, and a score of 2.34 to 3.66 indicating moderate activity and a score of 3.67 to 5 indicating high activity. The IPAQ has moderately high validity (0.46 - 0.96) and reliability (0.3) (20).

3.Eating Habits Questionnaire (EHQ)

The Parmenter and Wardle Nutrition Knowledge Questionnaire (1999) was designed based on Likert scale. Questions are multiple-choice and are scored on a scale of 1 to 5, where 1 represents the lowest level of nutritional knowledge and 5 signifies the highest. This scale is divided into the following five sections: Dietary Recommendations (DR), Sources of Foods (SOF), Choosing Everyday Foods (CEF), Diet-Disease Relationships (DDR), and Total Score (TS). Correct answers in each section carried a point value of one and each section had a corresponding maximum score (DR = 11, SOF = 69, CEF = 10, DDR = 20 and TS = 110). This questionnaire is a useful tool for examining the dietary choices and gaining a clearer understanding of the relationship between knowledge and nutritional behavior. It can also serve as a useful instrument to identify nutritional knowledge gaps within a society or as an assessments to measure the success and evaluating educational health and wellness programs. This scale has been tested for reliability (Cronbach's α = 0·74) and validity (0.7 - 0.97) (21).

4.Bruininks Oseretsky test-Short Form (BOT-2)

In this study, motor proficiency is defined as the score derived from the short form of the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2). The test designed to measure fine and gross motor proficiency in children and young adults aged 4-21. This version is categorized into four composite motor domains each containing two motor subtests i.e. 1. Fine Manual Control: Fine Motor Precision, Fine Motor Integration; 2. Manual Coordination:

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Manual Dexterity, Upper-Limb Coordination; 3. Body Coordination: Bilateral Coordination, Balance; 4. Strength and Agility: Running Speed and Agility, Strength. The total score indicates overall skill, including gross and fine skill. This test has necessary validity and reliability (0.9) (22).

Statistical and Data Analysis

The Kolmogorov-Smirnov test was employed to assess the normality of the data distribution, and Spearman's correlation coefficient was calculated to evaluate the correlation coefficients. Data analysis was conducted using SPSS V.26, with a significance level set at $P \leq 0.05$.

Results

Mean and standard deviation of height, weight and Body Mass Index (BMI) of subjects are in Tables 1. The Kolmogorov-Smirnov test was used initially to evaluate the normality of the data. The results indicated that the data distribution was normal (Table 2). Consequently, parametric tests were applied.

Table 1. Anthropometric characteristics of subject.

Variables	Mean	standard deviation
Age	12.42	1.92
Height	145.42	8.24
Weight	43.68	13.50
BMI	20.33	4.56

Table 2. Kolmogorov-Smirnov test to assess the normality of the data.

Variables	Ks-z	p-value
physical activity level	1.30	0.068
Nutrition knowledge	1.34	0.053
Motor proficiency	1.41	0.061
BMI	0.66	0.765

The participants had an average age of 12.42 years with a standard deviation of 1.92. The average BMI of female students was equal to 20.33±4.56. Table 3 presents the percentage, frequency, and distribution of the sample, as shown in Table 2, 12.8% of the participants reported low physical activity levels, 81.7% had moderate physical activity levels, and 5.5% had high physical activity levels.

Table 3. Classification of subjects based on different levels of physical activity.

Age	Low level		Moderate level		High level	
	Number	Percentage	Number	Percentage	Number	Percentage
10	10	14.2	55	78.5	5	7.3
11	8	11.4	59	84.2	3	4.4
12	11	15.7	55	78.5	4	5.8
13	7	10	59	84.2	4	5.8
14	9	12.8	58	82.8	3	4.4
Total	45	12.8	286	81.7	19	5.5

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The comparison of physical activity levels among the four groups—underweight, normal weight, overweight, and obese- indicated that a considerable proportion of underweight individuals (28.3%) exhibited high physical activity levels. Conversely, a notable percentage of those in the overweight and obese groups reported low physical activity levels (48.8% and 24.3%, respectively) (Table 4).

As shown in Table 4, the underweight group had the lowest frequency (11%), while the normal weight group had the highest frequency (56.7%).

Table 4. Classification of subjects based on different levels of physical activity.

Classified based on BMI	Total		Low level		Moderate level		High level	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Underweight	39	11	2	5.1	26	66.6	11	28.3
Normal weight	198	56.7	5	2.5	188	95	5	2.5
Overweight	43	12.3	21	48.8	20	46.5	2	4.7
Obese	70	20	17	24.3	52	74.3	1	1.4
Total	350	100	45	12.8	286	81.7	19	5.5

The results of Pearson's correlation test showed that Physical activity correlated negatively with BMI and correlated positively with motor proficiency, indicating that higher levels of physical activity were associated with improved motor skills among students ($P < 0.05$). As shown in Table 5, there is no significant relationship between nutritional knowledge with BMI and motor proficiency of girls aged 10 to 14 years old ($P>0.05$).

Table 5. Pearson's correlation test results between the overall scores of physical activity and nutritional knowledge with BMI and motor skills.

Variable	BMI		motor proficiency	
	P- Value	R	P- Value	R
Physical activity level	0.01 *	-0.29	0.05 *	0.213
Nutritional knowledge	0.32	0.07	0.391	0.162

Pearson's correlation test were used.*Significance level ($P < 0.05$)

Discussion

This study aimed to examine the relationship between physical activity and nutritional knowledge with BMI and motor skills among girls aged 10 to 14 years in schools located in Khanaqin during the COVID-19 pandemic. The results of the study indicated that physical activity correlated negatively with BMI and positively with motor proficiency among school girls aged 10 to 14 years. This research showed that decreased physical activity levels are associated with higher BMI in school children. However, there was no significant relationship between nutritional knowledge with BMI and motor proficiency. The COVID-19 pandemic has had a profound impact on mobility and lifestyles globally, including in Iraq. Such marked changes may raise the risk of negative health outcomes, obesity, and chronic (non-communicable) diseases.

The findings of this study regarding physical activity and BMI are consistent with Dobrowolski's research from (23). Changes in body weight can be anticipated if energy intake consistently exceeds or falls below daily energy requirements. Pellegrini et al. (24) reported a significant increase in weight and BMI, often associated with decreased physical activity, and an increased consumption of unhealthy foods, snacks, cereals, and sweets during lockdown. A study conducted in Lithuania, a different geographic region, showed that only a small percentage of participants gained weight during the quarantine, but it also indicated a decrease in physical activity and an increase in food

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consumption (25). Study by Baria et al (26) also reported a substantial decline in physical activity and an increase in BMI; Isolating people without proper support has resulted in negative changes to their lifestyle and body mass.

The results of the study indicated that physical activity correlated positively with motor proficiency. This finding is consistent with the findings of other researches, advanced performance in the fundamental movement skill depends on the successful progression of a specific motor task through the stages of transfer, application, and lifelong use, and these individuals usually participate in sport activities during adolescence (27-28). Proficiency in fundamental movement skills can increase individuals' interest in acquiring motor abilities and effectively improves motor skill development (29).

There was no significant relationship between nutritional knowledge with BMI and motor proficiency. A study conducted by Eskandarpour et al. (30) observed a statistically significant relationship between nutritional knowledge, attitude, and performance with BMI, as well as between nutritional attitude and performance with physical activity, This finding is inconsistent with the results of the current study, which could be due to the use of different questionnaires in the two studies or a lack of nutritional knowledge of the samples.

Moore et al. (31) reported that the COVID-19 pandemic has impacted children’s movement and game behavior in Canada. Additionally, a study by Phytanza et al. (32) reported that 80% of children’s gross motor skills were in the low range, and 20% of children’s gross motor skills were in the very low range during the COVID-19 pandemic.

A similar case has been reported (33) during the COVID-19 era, children have become overly involved in screen-based activities, with outdoor activities mostly limited to weekends. This has significantly negatively affected their motor skills due to increased sleeping duration, increased food intake, and increased television watching time (4). Studies have shown that regular physical activity improve motor function. It is important to recognize that the effect of physical activity on motor skills depends on the intensity and type of activity. People with nutritional knowledge usually try to eat a healthy and varied diet. They can make healthier choices about the types of foods they eat and avoid foods with low nutritional value and high calories.

Research has shown that during the COVID-19 pandemic, lifestyle changes, social restrictions, and changes in physical activity may affect nutrition and body weight. If we do not pay attention to this issue, the pandemic will negatively affect individuals, especially children, so current study suggest that parents be encouraged to participate in physical activities with their children at home. The pandemic has reinforced the importance of parents in helping to prevent children's motor skills from declining. In addition, current study recommend that intervention research be conducted in schools to increase children's knowledge and attitudes towards health and fitness. It is also important to implement policies aimed at improving the school environment and encouraging students to make healthy food choices.

Limitations and Strengths

Among the limitations of this research, current study can mention the small sample size, which was constrained by implementation limitations. Additionally, the study relied on self-report measures, which are susceptible to bias.

Conclusion

The results showed a significant inverse relationship between physical activity and individuals' BMI, as well as a significant direct relationship between physical activity and motor skill proficiency, meaning that as physical activity increased, students' motor skills improved. However, there was no significant relationship between nutrition knowledge

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and either BMI or motor skill proficiency. The findings of this study suggest that physical activity during the COVID-19 period improved BMI and motor proficiency in school girls. Thus, when physical activities are adapted to environmental conditions, they can help prevent the decline of motor skills in children and students during pandemics like COVID-19.

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CRediT authorship contribution statement

Project Administration, Writing– Original Draft Preparation, Supervision: MN, Formal Analysis, Investigation, Resources, Conceptualization, Methodology and Data Curation: SFH, Validation, Visualization, Writing– Review & Editing and Software: SH.

Declaration of Generative AI and AI-assisted technologies in the writing process

The writers attest that they worked alone to write and prepare this text, without the use of any professional writing services. Only the writers' original work and contributions are reflected in the text.

Conflict of interest

The authors have reported no conflicts of interest.

Ethical considerations

The study considered all ethical guidelines for human studies based on the Helsinki consensus statement and was approved by the ethical committee of Ilam University (IR.ILAM.REC.1402.007).

Data availability statement

Upon reasonable request, the corresponding author will provide the data supporting the study's conclusions.

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