Is there an association between physical activity level, nutritional status, biological maturation, and body satisfaction in adolescents?

¿Existe asociación entre el nivel de actividad física, el estado nutricional, la maduración biológica y la satisfacción corporal en adolescentes?

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Abstract

Objective: To verify the association between physical activity levels, nutritional status, biological maturation, and body satisfaction in adolescents.
Methods: The study included 250 adolescents, aged 14 to 19 years, both male and female, enrolled in a public reference school. Questionnaires were administered to measure physical activity level (IPAQ) and body satisfaction (Kakeshita silhouette scale). The students were instructed to answer the questions and indicate their perception of body image on the scale. Subsequently, anthropometric measurements (body mass, height, and trunk-cephalic height) were taken. Statistical analysis included the Chi-Square (X^2) test to verify differences between variables and multiple linear regression, with a significance level of 5% ($p<0.05$).
Results: Physical activity levels showed sensitivity concerning body satisfaction, biological maturation, nutritional status, and gender variables. Only biological maturation showed a significant association with physical activity levels, with girls tending to have lower physical activity levels compared to boys.
Conclusion: After puberty, the high levels of physical activity diverged from existing literature and indicated a warning for high levels of body image distortion among adolescents.

Keywords

Physical activity; nutritional status; puberty; body image; adolescent.

Resumen

Objetivo: Verificar la asociación entre los niveles de actividad física, el estado nutricional, la maduración biológica y la satisfacción corporal en adolescentes.
Métodos: El estudio incluyó a 250 adolescentes, de 14 a 19 años, tanto hombres como mujeres, matriculados en una escuela pública de referencia. Se aplicaron cuestionarios para medir el nivel de actividad física (IPAQ) y la satisfacción corporal (escala de siluetas de Kakeshita). Se les indicó a los estudiantes que respondieran las preguntas e indicaran su percepción de imagen corporal en la escala. Posteriormente, se realizaron mediciones antropométricas (masa corporal, estatura y estatura tronco-cefálica). El análisis estadístico incluyó la prueba Chi-Cuadrado (X^2) para verificar las diferencias entre las variables y la regresión lineal múltiple, con un nivel de significancia del 5% ($p<0,05$).
Resultados: Los niveles de actividad física mostraron sensibilidad con respecto a las variables satisfacción corporal, maduración biológica, estado nutricional y género. Solo la maduración biológica presentó una asociación significativa con los niveles de actividad física, observándose que las niñas tienden a tener niveles más bajos de actividad física en comparación con los niños.
Conclusión: Después de la pubertad, los altos niveles de actividad física divergieron de la literatura existente e indicaron una alerta sobre los altos niveles de distorsión de la imagen corporal entre adolescentes.

Palabras clave

Actividad física; estado nutricional; pubertad; imagen corporal; adolescente.

Introduction

Adolescence is a period characterized by intense physical, psychological, and social changes, which can lead to insecurities and influence maturation, body image, and the adoption of healthy habits such as diet and physical activity (Sadibolova et al., 2019). During this phase of life, physical activity plays a crucial role in psychophysical growth and development, identity formation, and habit development. It is both impacted by aspects related to adolescent well-being and influences those aspects (Feldman, Papalia & Wendkos, 2013; Moura et al., 2021). Santana et al. (2024) showed that during this period there is a direct relationship between psycho-emotional fragility, body dissatisfaction and insufficient physical activity.

Even so, physical activity levels in this age group have decreased in recent years due to the advent of technological devices and the consumption of low-nutritional-quality foods, negatively affecting body composition and quality of life (D'Ávila et al., 2019; Moura et al., 2021). More than 40% of the Brazilian population does not meet the recommended levels of physical activity, with adolescents showing high rates of overweight (Souza Júnior et al., 2021). Nutritional status is a critical factor to consider, as inadequate diet can result in malnutrition or overweight/obesity (Guerra, Farias & Florindo, 2016). This has been shown to affect anthropometric variables, muscle function, and the pace and quality of biological maturation in adolescence (Castro, Ochoa & Amoretti, 2024).

In this scenario, the Biological maturation is a natural process of human development toward adulthood, extending from childhood to adolescence, occurring non-uniformly, and conditioned by genetics, lifestyle, nutrition, and physical activity (Campos et al., 2021; Zuhri, 2023). This process can occur either early or late, impacting self-esteem and body perception, and provoking feelings of inadequacy or dissatisfaction with one's own body (Zuhri, 2023). It is important to highlight that during this period, social pressure and self-perception, both internal and external, are intensified (Irvine et al., 2019). Nutritional imbalances and sedentary behavior can aggravate problems related to body image and satisfaction, Bodega et al. (2024) point out in their review that adolescents with healthy habits are more satisfied with their own bodies.

This satisfaction can be conceptualized as the degree of contentment or discontentment a person feels regarding their own body, considering personal conceptions and external opinions from family, peers, and socially imposed standards (Hosseni & Pathy, 2020). It constitutes an important component of young people's mental health (Sadibolova et al., 2019). Body dissatisfaction at this stage of life is associated with body image distortion, even in eutrophic individuals, and is particularly prevalent in adolescents with overweight, obesity, and low levels of physical activity (Santana et al., 2024). This dissatisfaction can lead to concerns and apprehensions that may, in turn, result in the development of mental disorders (Branco, Hilário & Cintra, 2006; Griffiths et al., 2016).

Consequently, several studies (Silva et al., 2019; Bodega et al., 2024; Santana et al., 2024; Venturelli et al., 2024) have investigated the association between these variables in isolation, considering physical activity, nutritional status, biological maturation, and body satisfaction. Garcia et al. (2018) showed that levels of physical activity and biological maturation have an impact on the dimensions of health-related quality of life in young people. Venturelli et al. (2024) draw attention in their research to the prevalence of high levels of poor eating habits and low levels of physical activity among adolescents. In some regions, by 2030, global trends show that more than 80% of young people have insufficient daily physical activity scores.

However, there is a scarcity of research addressing these variables in an integrated manner, considering how these multiple aspects interrelate, especially during adolescence. It is believed that an integral analysis of these factors can provide valuable insights for the formulation of public policies and health programs that promote the healthy development of young people in a holistic manner.

Given the above, this study aims to investigate the association between physical activity level, nutritional status, biological maturation, and body satisfaction in adolescents. The central hypothesis is that higher levels of physical activity have a positive effect on better body composition, biological maturation and a greater degree of body satisfaction. It is expected that the results of this study will provide practical support for the development of interventions and public policies that promote healthy habits and

mental health in adolescents, as well as contribute to educational and health programs that encourage regular physical activity as a key factor for overall well-being during adolescence.

Method

This is a descriptive, quantitative, and cross-sectional study (Thomas, Nelson & Silverman, 2009). The study was approved by the Research Ethics Committee (CEP) of the Health Sciences Center at the Federal University of Pernambuco, under approval number 5.356.989, and followed the ethical principles established by Resolution 466/12 of the National Health Council (CNS), according to the guidelines of the Declaration of Helsinki.

Participants

A presentation was given to the administration, coordination, and teachers of the public high school in Recife, Pernambuco, Brazil, where the research was conducted. To be included in the study, participants had to be male or female, aged 14 to 18 years, and enrolled and regularly attending classes at the mentioned school. Individuals who did not participate in any stage of the research were excluded from the study.

Of the 525 students enrolled and invited to participate, 178 declined the invitation, resulting in 347 students. After applying the inclusion and exclusion criteria, the final sample consisted of 250 adolescents, aged 14 to 18 years, who agreed to participate and whose guardians signed the Informed Assent Form (IAF) and the Informed Consent Form (ICF).

Procedure

Data collection began after the approval of the ethics committee, the institution's coordination, and the obtaining of signatures on the IAF and ICF. The 250 adolescents who agreed to take part in the study and met the inclusion and exclusion criteria, as described above, were collected by pre-arrangement, with the agreement of the school coordinators, in a reserved room, during the afternoon shift, between 1 and 5 pm. The 5 classes that took part in the study were reversed one at a time, so as to minimize disruption to the students' teaching routine. The surveys were carried out by 4 previously trained researchers, who explained the aim of the research, read the questionnaires, handed out the instruments and were attentive to any questions that might arise.

Initially, the level of physical activity (PAL) was checked using the International Physical Activity Questionnaire (IPAQ) (Guedes, Lopes & Guedes, 2005; Matsudo et al., 2001). Next, body image perception was assessed using the Kakeshita Silhouette Scale (Kakeshita, 2008; Laus et al., 2013) and, finally, anthropometric measurements (body mass, height, height and torso-cephalic length) were checked. After collection, all the information was recorded in the corresponding databases. It should be noted that the findings of this investigation were shared with the school management, as agreed, in order to serve as a basis for future activities and strategies to help promote healthy habits in adolescence.

Instruments

The IPAQ (Matsudo et al., 2001) was used to measure PAL indirectly, considering walking activities, moderate-intensity physical activities, and high-intensity physical activities. The IPAQ was validated for Brazilian adolescents by Guedes, Lopes & Guedes (2005). The frequency (days/week), time (minutes/day), and intensity (METs) corresponding to each of these dimensions were multiplied, and the total weekly activity volume was calculated by summing the obtained products. Participants were classified as very active, active, irregularly active A, irregularly active B, or sedentary according to the instrument itself. For this study, the first two categories were grouped as "active" and the last three as "sedentary" (Franceschin & Veiga, 2020).

To measure body image perception and body satisfaction, the Kakeshita Silhouette Scale (Kakeshita, 2008) was used, validated for adolescents by Laus et al. (2013). The scale consists of 15 figures of each sex, with pre-determined average values and Body Mass Index (BMI) ranges, drawn based on the anthropometric measures of the Brazilian population. Participants selected a figure that matched their perception of their current body image and a second figure representing their desired body image.

Anthropometric measurements were obtained as follows: height was measured with a Sanny stadiometer (São Paulo, Brazil), with an accuracy of 0.1 cm; body mass was measured with a Filizola digital scale (São Paulo, Brazil), with an accuracy of 100 grams; trunk-cephalic height was measured with the participant seated on a 90° adjustable bench using a Starrett® tape measure (Itu, Brazil); and leg length was calculated by subtracting trunk-cephalic height from total height, both in centimeters. BMI was calculated by dividing total body mass by height squared. Biological maturation was assessed by Peak Height Velocity (PHV), estimated using the equation proposed by Mirwald et al. (2002).

The sample size was determined using the OpenEpi software (version 3), designed for epidemiological statistics (Dean et al., 2013). The calculation considered the finite population correction factor, with a statistical power of 80% and a 95% confidence interval, resulting in an initial minimum sample size of 191 participants. To ensure representativeness and validity of the results in light of potential losses during data collection, an adjustment for an estimated 20% attrition rate was applied, increasing the final sample size to 230 adolescents. This procedure was based on previous studies, such as Fantineli et al. (2020), which explored the relationship between body image, nutritional status, and physical activity in adolescents, providing methodological support for determining the sample size.

Data analysis

The data were tabulated using Microsoft Excel® and analyzed with the Statistical Package for Social Sciences (SPSS®) software, version 20.0 (IBM, USA). Data normality was assessed using the Shapiro-Wilk test, which indicated a non-normal distribution, justifying the use of non-parametric statistical methods. Descriptive analysis was performed using mean and standard deviation (SD) to characterize the sample. Pearson's chi-square test (χ^2) was applied to compare differences between genders and categorical variables. To evaluate the association between the level of physical activity (LPA) and body satisfaction, maturation, and nutritional status, multiple linear regression was used, allowing for the analysis of relationships among multiple predictor variables. Regarding Crámer's V, the closer it is to 0, the weaker the association between the variables and the closer it is to 1, the stronger the association (Lee, 2016). Poor association: $V \leq 0.2$; Moderate association: $0.2 < V \leq 0.6$; Strong association: $V > 0.6$. A significance level of 5% ($p < 0.05$) was adopted for all analyses.

Results

In Table 1, the description of the total sample and stratification by gender for age, height, weight, and BMI variables is presented. The sample included 250 adolescents, with 131 (52.4%) females and 119 (47.6%) males. The average age was 16.40 (±1.00) years, the average height was 168.00 (±0.08) cm, and the average weight was 65.30 (±18.10) kg. The average BMI was 23.10 (±5.60) kg/m^2. The post-pubertal maturational stage was the most frequent, with 215 occurrences in the total sample. Among females, the majority (131) were in the post-pubertal stage, while among males, adolescents were predominantly in the pubertal stage (30). The prepubertal stage had the fewest occurrences (5), occurring only among males.

Table 1. Description of anthropometric variables (age, height, weight and BMI) and stage of maturation for the total sample and stratified by gender.

Variables	Total sample	Female	Male
	Mean ± SD (n= 250)	Mean ± SD (n= 131)	Mean ± SD (n= 119)
Age (years)	16.40±1.00	16.30±1.04	16.40±0.95
Height (cm)	168.00±0.08	162.00±0.06	174±0.06
Weight (kg)	65.30±18.10	62.3±16.8	68.60±18.90
BMI (kg/m^2)	23.10±5.60	23.50±5.79	22.60±5.37
Maturation stage			
Pre-pubescent	5	0	5
Pubescent	30	0	30
Post-pubertal	215	131	84

Note: BMI=Body Mass Index

Table 2 presents the distribution of physical activity level (PAL), body satisfaction, maturation stage, and nutritional status, stratified by gender. For Physical Activity Level (PAL), most active adolescents

were male (51.6%), while sedentary individuals were predominantly female (77.1%). The association between gender and physical activity level was considered weak (χ^2 = 0.002; Cramér's V = 0.200).

Regarding Body Satisfaction, among those satisfied with their body, men represented the majority (59.2%). In the group wishing to reduce their body size, women were predominant (62.2%), while among those wanting to increase their body size, men were slightly more prevalent (53.3%). The association between body satisfaction and gender was classified as weak (χ^2 = 0.018; Cramér's V = 0.180). In terms of the Maturation Stage, all pre-pubertal and pubertal individuals were male (100%), while the majority of post-pubertal individuals were female (60.9%). The association between maturation stage and gender was moderate (χ^2 < 0.001; Cramér's V = 0.423).

For Nutritional Status, the prevalence of underweight was higher among women (87.5%), while men predominated among eutrophic individuals (53.5%). Among those overweight and obese, women represented the majority (59.2% and 61.1%, respectively). The association between nutritional status and gender was weak (χ^2 = 0.043; Cramér's V = 0.180).

Table 2. Distribution of Physical Activity Level, Body Satisfaction, Maturation Stage, and Nutritional Status Stratified by Gender

	Gender		*X²**	Effect size**
	Female (n= 131)	Male (n= 119)		
PAL				
Active (%)	48.4	51.6	0.002*	0.200
Sedentary (%)	77.1	22.9		Poor association
Body satisfaction				
Satisfied (%)	40.8	59.2		0.180
Do you want to decrease (%)	62.2	37.8	0.018	Poor association
Do you want to increase (%)	46.7	53.3		
Maturation stage				
Pre-pubescent (%)	0.0	100.0		0.423
Pubescent (%)	0.0	100.0	<0.001*	Moderate association
Post-pubertal (%)	60.9	39.1		
Nutritional status				
Low weight (%)	87.5	12.5		0.180
Eutrophic (%)	46.5	53.5	0.043	Poor association
Overweight (%)	59.2	40.8		
Obese (%)	61.1	38.9		

Note: *Pearson χ2 test; **V for Crámer; Physical activity level=PAL

Table 3. Association Between Physical Activity Level and Predictive Variables: Body Satisfaction, and Nutritional Status by gender)

		Nutritional status						
Gender	PAL	Eutrophic n (%)	Over-weight n (%)	Obese n (%)	Low-weight n (%)	Total	X²*	Effect size**
Female	Active	57 (54.8%)	23 (22.1%)	19 (18.3%)	5 (4.8%)	104	0.801	0.087
	Sedentary	16 (59.3%)	6 (22.2%)	3 (11.1%)	2 (7.4%)	27		Poor association
Male	Active	79 (71.2%)	18 (16.2%)	13 (11.7%)	1 (0.9%)	111	0.919	0.064
	Sedentary	5 (62.5%)	2 (25.0%)	1 (12.5%)	0 (0%)	8		Poor association
		Body satisfaction						
Gender	PAL	Satisfied n (%)	Dissatisfied increase n (%)	Dissatisfied decrease n (%)		Total	X²*	Effect size**
Female	Active	18 (17.3%)	18 (17.3%)	18 (17.3%)		18	18	18
	Sedentary	2 (7.4%)	14 (51.9%)	11 (40.7%)		27		Moderate association
Male	Active	29 (26.1%)	45 (40.5%)	37 (33.3%)		111	0.142	0.181
	Sedentary	0 (0%)	3 (37.5%)	5 (62.5%)		8		Poor association

Note: *Pearson χ2 test; **V for Crámer; Physical activity level=PAL

The results in Table 3 indicate the association between physical activity level (PAL) and predictive variables such as nutritional status and body satisfaction, separated by gender. For Nutritional Status among women, the physical activity level showed a weak association with nutritional status (χ^2 = 0.801; Cramér's V = 0.087). Most active women were eutrophic (54.8%), while non-active women also predominantly fell into the eutrophic category (59.3%). Overweight was the second most prevalent category in both groups. Among men, the association was also weak (χ^2 = 0.919; Cramér's V = 0.064). Active men were predominantly eutrophic (71.2%), with a lower prevalence of obesity and underweight, while non-active men showed similar patterns.

Regarding Body Satisfaction, the association between physical activity level and body satisfaction was moderate among women (χ^2 = 0.040; Cramér's V = 0.222). Most active women were dissatisfied with their body, wanting to reduce it (55.8%), while among non-active women, dissatisfaction due to wanting to increase body size was more common (51.9%). For men, the association was weak (χ^2 = 0.142; Cramér's V = 0.181). Active men showed higher dissatisfaction due to wanting to increase body size (40.5%), whereas among non-active men, dissatisfaction due to wanting to decrease body size was predominant (62.5%). These findings highlight important gender differences in the relationship between physical activity, nutritional status, and body satisfaction, although the associations are generally weak to moderate.

Discussion

The aim of this study was to investigate the association between physical activity levels, nutritional status, biological maturation and body satisfaction in adolescents. In this sense, this study revealed a sensitivity of PAL levels to the other variables mentioned above and gender when considered together. These findings align with existing literature, which highlights the significant impact of physical activity on lifestyle and adolescents' perceptions of their physical bodies on physical activity (Carvalho et al., 2020; Fantineli et al., 2020; De Sousa Ferreira et al., 2021; Furtado et al., 2023).

A major finding of the study was the high percentage of adolescents classified as physically active. This result corroborates the findings of Furtado et al. (2023), who found that 53.95% of teenagers were physically active. A review study that analyzed studies from 1990 to 2005, found the prevalence of adolescents exposed to low levels of physical activity ranging from 39% to 93.5% (Tassitano et al., 2007), which compared to our result, it is observed that adolescents have improved their levels of physical activity practiced (Hallal et al., 2012; Silva et al., 2018; Souza et al., 2022). This suggests that new strategies and public policies may be emerging and having positive effects on young people's health, fostering habits that promote a better quality of life (Ferreira et al., 2019).

Regarding the level of physical activity, boys were more active than girls, a trend that is already well-established in the literature (Tassitano et al., 2007; Hallal et al., 2012; Silva et al., 2018; Ferreira et al., 2021; Furtado et al., 2023), but why do girls tend to be less physically active? We can point to the sociocultural context and the types of activities on offer, which are detrimental to girls' engagement (Ferreira et al., 2018; Do Nascimento et al., 2023), the marked hormonal changes that occur mainly in adolescence and the stimuli and/or types of physical education classes offered at school, which are not as attractive to the female public compared to the male public (Fortes et al., 2012; Soares & Hallal, 2015). However, this low percentage of physical activity in girls has resulted in higher levels of common mental disorders among them (Pearson et al., 2019; Ribeiro et al., 2020).

Lower PAL levels can pose significant risks to physical and mental health, not only for adolescents and children but also for adults (Sampasa-Kanyinga et al., 2020; Pearce et al., 2022). Individuals with low PAL are more susceptible to problems such as low self-esteem and a risk of depression (Furtado et al., 2023). Additionally, a sedentary lifestyle, characterized by low energy expenditure and high caloric intake, can lead to negative changes in anthropometric and metabolic patterns (Leite, Corona & Habitante, 2022).

Although nutritional status did not show a significant association with PAL in this study, there was a high presence of eutrophic adolescents. Similar data were found by Zanuzo, Nishiyama & Camara (2021), who revealed a high prevalence of eutrophy among physically active adolescents. De Sousa Ferreira et al. (2021) also found a high rate of body dissatisfaction (78.85%) while more than half of the sample was classified as eutrophic, corroborating the results of this study.

The low level of body satisfaction found in this study is consistent with existing literature, which shows a high impact of body mass and physical fitness on body dissatisfaction among adolescents, with variations reaching up to 75% (Shoraka, Amirkafi & Garrusi, 2019). Despite the lack of a significant association with PAL, similar data were observed by Carvalho et al. (2020), who also found no significant differences in body satisfaction associated with PAL in adolescents. Fantineli et al. (2020) reported similar results, indicating that severe body dissatisfaction is often related to overweight and obesity in both

genders. Additionally, they observed that girls in more advanced stages of maturation seem to be more susceptible to these issues.

It is important to highlight that females showed greater susceptibility to the studied variables, particularly to PAL, which was more significantly affected by the other variables. Girls frequently face social and intrapersonal criticism related to aesthetic standards, which can amplify the perception of overweight and obesity, even with an ideal body composition (Branco, Hilário & Cintra, 2006; Pinho et al., 2019).

During the growth spurt, girls experience physiological and bodily changes earlier, between 9 and 14 years, while boys undergo these changes between 11 and 16 years (Feldman, Papalia & Wendkos, 2013). Bacil et al. (2020) highlights that early maturation can reduce interest in physical activities due to bodily changes, and this interest may decrease further with maturity. However, the results of this study do not confirm this trend, indicating that even among adolescents with full maturity, PAL was not significantly impacted. This discrepancy suggests a higher sensitivity in females (Zuhri, 2023; Fantineli et al., 2020; Campos et al., 2021) and reinforces the observation that girls tend to present lower PA levels compared to boys.

Overall, it is evident that adolescents face significant challenges in understanding their bodies during this transition to adulthood, with physical activity levels playing a crucial role in body composition (Guerra, Farias & Florindo, 2016). Additionally, there is some ambiguity regarding physical activity, as excess can have detrimental effects, leading to clinical conditions that negatively impact mental health, such as sleep quality, feelings of loneliness, and socialization (Wroblevski et al., 2022).

This study has several limitations that should be highlighted. Firstly, the data was obtained through questionnaires, subject to the subjectivity of the adolescents. Secondly, the sample refers to a public school in the city of Recife, state of Pernambuco, which does not allow the results to be generalized to other regions and states of Brazil, a country marked by great social inequalities and cultural diversity, which has great potential to alter the data relating to these variables. Thirdly, the sample loss resulted in a reduced number of adolescents, which may have limited the strength of the results obtained. In addition, the analysis did not compare adolescents in total and by gender, nor did it separate them by age, since we know that adolescence is a very long phase.

These limitations indicate the need for future studies that include a larger, more diverse and randomized sample, as well as a more comprehensive analysis of variables related to nutritional status and body satisfaction, such as including an analysis of adolescents' food consumption, which is one of the determinants of their body composition. Consider different social and economic contexts, including additional variables such as income, age, level of education of those responsible and access to leisure spaces and/or school physical education classes. We could also suggest intervention studies with physical activity and food and nutrition education with adolescents and check whether both interventions have an effect on the nutritional status and body satisfaction of adolescents. Such suggestions could help to better elucidate the complex interactions between NAF, nutritional status, biological maturation and body satisfaction.

Conclusions

The results of this study highlight that PAL are sensitive to body satisfaction, biological maturation, nutritional status, and gender variables, although the significant association was limited to the maturational stage. A high concentration of active and eutrophic adolescents was observed, with a predominance of dissatisfaction with their body image.

The findings underscore a significant concern regarding body image distortions among adolescents. This dissatisfaction may predispose individuals to psychological disorders, exacerbated by the cultural influence of media and imposed aesthetic standards.

Moreover, the study reveals that even among adolescents who have passed the pubertal stage, the prevalence of high PAL diverges from some previous findings in the literature. This may be related to recent public policy strategies promoting new habits and lifestyles.

Therefore, it is essential to conduct further research to deepen the understanding of the associations between the investigated variables and to explore lifestyle factors impacting the psychological well-being of youth. Additional investigations could provide valuable insights for the development of more effective interventions that promote both physical and mental health during adolescence.

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