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Influence of socioeconomic status, age, body fat, and depressive symptoms on evel of physical activity in adults: a path analysis

Tatiana Carvalho Reis Martins (https://orcid.org/0000-0001-9436-8970) [1]
Lucinéia de Pinho (https://orcid.org/0000-0002-2947-5806)[2]
Maria Fernanda Santos Figueiredo Brito (https://orcid.org/0000-0001-5395-9491)[2]
Geórgia das Graças Pena (https://orcid.org/0000-0002-0360-223X)[3]
Rosângela Ramos Veloso Silva (https://orcid.org/0000-0003-3329-8133) [4]
André Luiz Sena Guimarães (https://orcid.org/0000-0002-3162-3206) [5]
Marise Fagundes Silveira (https://orcid.org/0000-0002-8821-3160) [5]
João Felício Rodrigues Neto (http://orcid.org/0000-0002-6496-0460) [5]

Abstract *Physical activity is a complex behavior influenced by sociodemographic and clinical factors. A better understanding of the relationships between these factors is essential to better understanding their influence on physical activity. The objective of this study was to examine the association between socioeconomic status, age, body fat, and depressive symptoms and level of physical activity among adults. We conducted a cross-sectional population-based study with 808 individuals to examine the interrelations between the above factors and their influence on level of physical activity using path analysis. Age had a significant direct negative effect on level of physical activity (β = -0.113, $p < 0.004$) and a significant positive effect on body fat (β = 0.376, $p < 0.001$). Depressive symptoms were negatively influenced by socioeconomic status (β = -0.126, $p < 0.001$) and positively influenced by age (β = 0.244, $p < 0.001$) and body fat (β = 0.169; $p < 0.004$). Socioeconomic status, body fat and depressive symptoms did not directly influence level of physical activity. This study concludes that level of physical activity declines with advancing age.*

Key words *Physical activity, Adiposity, Depressive symptoms, Socioeconomic status*

[1] Programa de Pós-Graduação em Enfermagem. Universidade Federal do Mato Grosso do Sul. Av. Ranulpho Marques Leal 3484, Distrito Industrial. 79620-080 Três Lagoas MS Brasil. tatycnn@hotmail.com
[2] Programa de Pós-Graduação em Cuidados Primários, Universidade Estadual de Montes Claros (Unimontes). Montes Claros MG Brasil.
[3] Faculdade de Medicina, Universidade Federal de Uberlândia. Uberlândia MG Brasil.
[4] Departamento de Educação Física, Unimontes. Montes Claros MG Brasil.
[5] Programa de Pós-Graduação em Ciências da Saúde, Unimontes. Montes Claros MG Brasil.

Introduction

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure above the rate in the resting state[1] and is influenced by intrapersonal, interpersonal, environmental, political, and community factors[2,3]. Regular physical activity has been associated with health benefits and improved quality of life[4,5]. Doing regular physical activity can also reduce the risk of developing a host of diseases and chronic conditions and increase life expectancy. In contrast, physical inactivity may contribute to death from cardiovascular disease[5-8].

The ecological perspective suggests that physical activity is influenced by the interaction between demographic, physiological, social, and environmental factors[9]. However, further research is needed to better understand the influence of these factors on physical activity and their interrelations. Understanding why people are physically active or inactive is essential for planning evidence-based public health interventions[2].

The determinants of physical activity has drawn interest from epidemiologists and public health professionals and research in this area provides important inputs to inform actions and policies designed to minimize the health effects of physical inactivity[10,11]. Although interest in this topic in Brazil has also grown, investigations with more complex study designs remain scarce[12].

There is a predominance in the literature of studies examining the direct effect of sociodemographic, clinical, and anthropometric factors on physical activity. However, it is important to consider that these factors may also influence physical activity indirectly due to their interactions[13-16]. The objective of this study was therefore to examine the association between socioeconomic status, age, body fat, and depressive symptoms and level of physical activity among adults. It does this by proposing an explanatory model built around a path diagram depicting the direct and indirect associations between these variables and their influence on level of physical activity among adults.

Methods

Study area and population

We conducted a cross-sectional population-based study with adults aged 18 years and over residing in private permanent households in the urban area of Montes Claros in the State of Minas Gerais, Brazil[17].

Sampling plan

This study used population data from a previously published epidemiological study analyzing polymorphism of the leptin receptor (rs1137101) and its association with obesity and cardiovascular disease in Montes Claros, Minas Gerais. We used cluster sampling, adopting a design effect of 2.0 as described in previous studies[18,19], resulting in a minimum sample size of 750 individuals.

The previously defined sample size for the epidemiological study met the assumptions of the present study, which applied path analysis, where the recommended number of observations in the sample is between 250 and 500[20].

Data collection

The data were collected between January 2012 and March 2013 by previously trained interviewers supervised throughout the collection process. A pilot study was conducted with a convenience sample to calibrate the interviewers. The data were double entered using Epi Info® 3.5.4 (Centers for Disease Control and Prevention, Atlanta, USA) and checked for consistency.

Study variables

We applied an individual questionnaire devised to collect information on the following: sociodemographic characteristics (sex, age, civil status, education, socioeconomic status); body fat; depressive symptoms; and frequency of physical activity (PA).

Frequency of PA was assessed using the International Physical Activity Questionnaire long form (IPAQ-8) validated for use in Brazil[21]. We

calculated the total time (in minutes) spent on walking and moderate and vigorous activity in the domains work, mode of transport, household (domestic activities), recreation, sport, exercise, and leisure[11].

Socioeconomic status was based on the Economic Classification Criteria Brazil proposed by the Brazilian Market Research Association (ABEP)[22], with total scores ranging from 0 and 46. This variable was analyzed as a continuous variable where the higher the score the higher the purchasing power.

Body composition was assessed by bioelectrical impedance analysis (BIA) using the BIA 310 Bioimpedance Analyzer (Biodynamics, England), applying a low range (500 to 800mA) and high frequency (50kHz) current with electrocardiogram gel electrodes (LecTec Corporation®, USA). Before the test, height and weight were measured with the participant wearing light clothes, no accessories, and having emptied the bladder and the time of the last meal was noted. The test was not carried out with individuals who reported having consumed a large amount of alcohol on the previous day, were using metallic prosthetics, and had severe heart disease. The following variables were considered: weight (W), resistance (R), reactance (Xc), impedance (Z), and phase angle (PA)[23].We used the body fat percentages provided by the device[24].

Depressive symptoms were assessed using the Portuguese version of the Beck Depression Inventory (BDI)[25,26] The BDI is a self-administered questionnaire consisting of 21 sets of four statements ranked in terms of severity and scored from 0 to 3, with total possible scores ranging from 0 to 63. This variable was analyzed as a continuous variable, where higher total scores indicate more severe depressive symptoms[26].

Theoretical model

Using path analysis[31,32], a hypothetical model was constructed (Figure 1) to assess the influence of the interrelations between socioeconomic status, age, body fat, and depressive symptoms on frequency of total physical activity[13,15,16,27-30].

The main outcome was frequency of physical activity and the explanatory variables were socioeconomic status, age, body fat, and depressive symptoms. The model tested the following hypotheses: socioeconomic status and body fat have a direct effect on depressive symptoms and frequency of physical activity and an indirect effect on frequency of physical activity, mediated by depressive symptoms; age has a direct effect on body fat, depressive symptoms, and frequency of physical activity and indirectly influences frequency of physical activity mediated by body fat and depressive symptoms; and depressive symptoms have a direct effect on frequency of physical activity.

Figure 1 illustrates the relations between the variables and causal paths of the hypothetical model. The variables are represented by rectangles and the associations by arrows or paths (from the independent variable to the dependent variable)[33,34].

Statistical analysis

All variables were described using the measures center, variability, skewness (sk), and kurtosis (ku). Skewness values of > than 3 and/or ku values of > than 7 were deemed to indicate departure from normal distribution and received log transformation[36]. The missing values were imputed using linear regression. Multivariate regression was performed (path analysis model) and direct and indirect effects were quantified using standardized coefficients. The significance of the estimated coefficients was tested based on the ratio between the coefficient value and its standard error (critical ratio - CR), where CR values of ≥ 1.96 and ≤ -1.96 ($p \leq 0.05$) were deemed to be statistically significant[33].

The following indices were used to assess goodness of fit: Bentler's comparative fit index (CFI), which compares the fit of the study model with that of the baseline model; and the goodness of fit index (GFI), which calculates the proportion of variance between the variables explained by the adjusted model. Values above 0.90 were deemed to indicate good fit[31,33,35].

The root mean square error of approximation (RMSEA) was also used as a test of close fit, comparing the test model and saturated model using the same dataset.[35] RMSEA values below 0.10 were deemed to indicate reasonable fit[33]. The absolute fit index ($X^2/d.f$) was also used to assess the goodness of fit test based on the ratio between the model's X^2 value and its degrees of freedom. This index is considered an absolute value because it does not compare the model with any other model[35]. Values below 5 were deemed to indicate acceptable fit[33,35].

The parameters were computed using the maximum likelihood method with the AMOS statistical software (version 18).

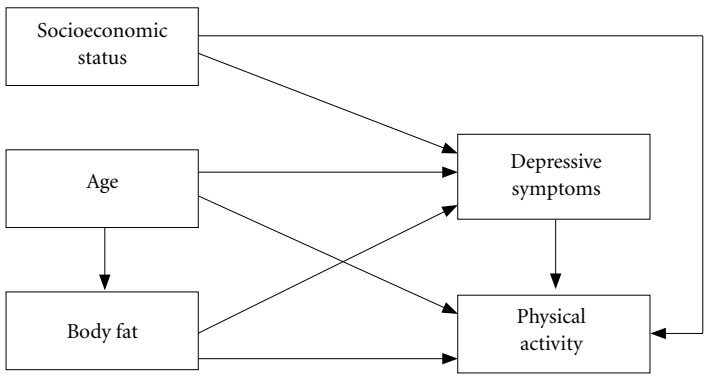

Figure 1. Hypothetical model used to determine the associations between socioeconomic status, age, percentage body fat, and depressive symptoms and their influence on physical activity. Montes Claros, MG, 2012-2013.

Ethical aspects

The study was approved by Montes Claros State University's Research Ethics Committee.

Results

A total of 808 individuals participated in the study, 52.7% of whom were women. A little over half of the sample were aged 35 and over (54%) and married or living in stable union (54.6%). Almost half of the sample (48.1%) had completed over 12 years of study and 46% of participants had a monthly family income of up to R$1,244.00, or two minimum salaries.

Table 1 presents the descriptive measures of the variables that make up the hypothetical model (age, body fat, depressive symptoms, socioeconomic status, and frequency of physical activity). The mean age of participants was 44.2 years (SD ± 17.8) and mean percentage body fat was 27.4% (minimum 3% and maximum 50%). The mean total scores for depressive symptoms and socioeconomic status were 6.8 (SD ± 6.4) and 18.1 (SD ± 5.8), respectively. The values for these variables did not show severe departure from the normal distribution (sk > 3 and Ku > 10). The multivariate kurtosis coefficient (ku_M) was 8.41.

Figure 2 shows the adjusted structural model and coefficients for all its components. The model showed adequate fit: $X^2/d.f$ = 1.343; CFI = 0.999, GFI = 0.999; RMSEA = 0.021 (90% CI 0.000-0.099).

Age had a significant direct negative effect on level of physical activity (β=-0.113; p=0.004). Depressive symptoms were positively influenced by age (β=0.244; p<0.001) and body fat (β=0.169; p<0.001) and negatively influenced by socioeconomic status (β=-0.126; p<0.001). The findings show that there was a direct positive association between age and body fat (β=0.376; p<0.001). Socioeconomic status, body fat, and depressive symptoms did not directly influence level of physical activity (Table 2). Finally, age directly influenced frequency of physical activity, accounting for 89.7% of the total effect (not mediated by other variables) (Table 3).

Discussion

The findings show that there was significant relation between age and physical activity, depressive symptoms, and body fat and that depressive symptoms were influenced by percentage body fat and socioeconomic status.

The data presented also show that age had a direct negative influence on physical activity, corroborating the findings of previous international[37-39] and national studies[14,15,40]. A study in Portugal with 37,692 individuals reported a significant inverse association between age and different types of physical activity[37], while a population-based study in the north of Minas Gerais

Table 1. Sociodemographic and clinical characteristics and physical activity. Montes Claros, MG, 2012-2013.

Variable	n	Mean (SD)	Median	Minimum	Maximum	Skewness	Kurtosis
Age (years)	808	44.2 (17.8)	42.0	18.0	99.0	0.44	-0.61
Body fat (%)	718	27.4 (8.8)	27.4	3.0	50.0	-0.24	-0.16
Depressive symptoms	808	6.8 (6.4)	5.0	0	38.0	1.50	2.49
Socioeconomic status	808	18.1 (5.8)	17.0	6.0	42.0	1.03	1.40
Total PA	808	938.5 (5.8)	560	0	6960.0	2.06	4.83

PA: physical activity; SD: standard deviation.

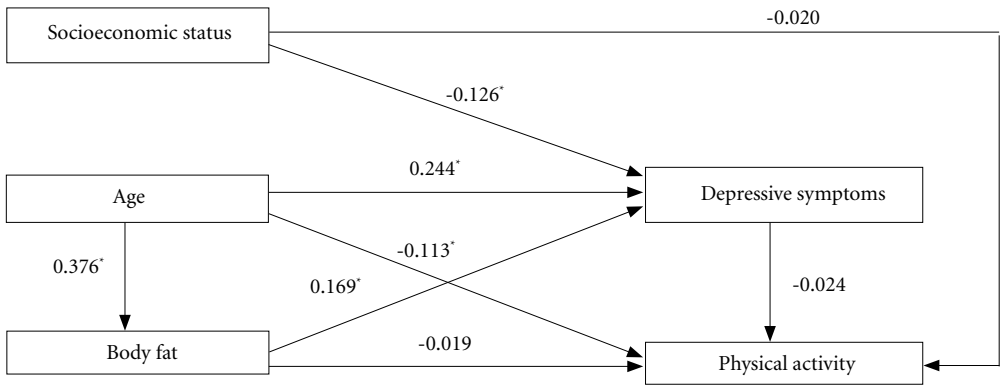

Figure 2. Adjusted model showing the association between physical activity, socioeconomic status, age, percentage body fat, and depressive symptoms. Montes Claros, MG, 2012-2013.

* significant (p- value <0.05)

showed that the frequency of physical activity decreased with increasing age[15]. A nationwide study conducted with 45,448 individuals showed that physical inactivity increased after the age of 55 and was greater among older people[40]. This may be partially explained by the fact that physical demands tend to decrease with increasing age[37]. Furthermore, advancing age is associated with changes in social roles and major transitions, including moving out of the family home and changes in the school/ work environment and financial circumstances. Many of these transitions are linked to health behaviors, including physical activity[38].

Our findings show a positive direct association between age and depressive symptoms. A nationwide survey of depressive symptoms among US adults conducted between 2005 and 2010 reported that prevalence increased with age[27], while a nationwide population-based survey in Brazil documented significant differences in self-reported medical diagnosis of depression between age groups, showing that prevalence was higher among individuals aged between 60 and 64 years[28].

The data presented also show that age had a significant direct effect on body fat, corroborating the findings of other studies with the Brazilian population[15,27,28,40,41]. This may be explained by the fact that the aging leads to changes in physiological processes associated with body fat accumulation, such as slowing metabolism and hormonal changes, which can contribute to increased body adiposity levels[42].

The results also show that socioeconomic status had a significant direct negative effect on de-

Table 2. Direct and indirect effects of age, depressive symptoms, body fat, and socioeconomic status on level of physical activity. Montes Claros, MG, 2012-2013.

Effects	Standardized Coefficient	p-value
Level of PA ← **Socioeconomic status**		
Direct	-0.020	>0.050
Depressive symptoms path	0.003	>0.050
Level of PA ← **Age**		
Direct	-0.113	0.004
Depressive symptoms path	-0.006	>0.050
Body fat path	-0.007	>0.050
Level of PA ← **Body fat**		
Direct	-0.019	>0.050
Depressive symptoms path	-0.004	>0.050
Level of PA ← **Depressive symptoms**		
Direct	-0.024	>0.050
Body fat ← **Age**		
Direct	0.376	<0.001
Depressive symptoms ← **Age**		
Direct	0.244	<0.001
Depressive symptoms ← **Body fat**		
Direct	0.169	<0.001
Depressive symptoms ← **Socioeconomic status**		
Direct	-0.126	<0.001

Table 3. Proportion of direct and indirect effect on total effect of age on level of physical activity. Montes Claros, MG, 2012-2013.

Effects	Standardized Coefficient	Proportion of direct and indirect effect
Level of PA ← age		
Total	-0.126	
Direct	-0.113	89.7
Depressive symptoms path	-0.006	4.8
Body fat path	-0.007	5.5

pressive symptoms, which is consistent with the findings in the literature[28,43,44].

The association between socioeconomic status and physical activity in our study was not significant. These results contrast with the findings of a prospective cohort study with 16,571 British men and women using structural equation modeling, which observed that social class was associated with physical activity[45]. This discrepancy may be due to the fact that the two countries have completely different socioeconomic contexts.

Body fat was shown to have a significant positive effect on depressive symptoms, which is in line with the findings of a study with US adults using path analysis[29]. Increased body mass index may influence the development of depression through biological mechanisms such as inflammation and dysregulation of the stress hormone system, increased risk of developing other diseases, and the negative effects of overweight on self-image[46]. Although our study did not identify an association between these variables and frequency of physical activity, a previous study reported that physical activity is a protective factor for many physical conditions, promoting adequate body mass index and better mental health[30].

Body fat did not have a significant direct effect on physical activity, which may be partially explained by the fact that daily physical activity alone many be insufficient to maintain body composition and health-related physical fitness[47].

The direct relationship between age and frequency of physical activity was the most important association observed by this study, explaining most of the effect. These findings show that differences between age groups should be taken into account when planning, implementing, and reorienting policies and interventions aimed at increasing levels of physical activity[15,48], focusing on the population subgroups most likely to adopt sedentary behaviors[15]. Promoting physical activity can contribute to improving health indicators and quality of life[10,15].

In the adjusted structural model, the indirect associations between the variables were not statistically significant, as hypothesized by the study. A possible explanation is that the coefficient values of the indirect effects mediated by depressive symptoms and body fat were low and not significant. Further research exploring the relationship between individual, social, and environmental factors and their influence on physical activity is needed[13].

By identifying the direct and indirect pathways linking socioeconomic status, age, body fat, and depressive symptoms and their influence on physical activity, this study sought to go beyond the assessment of direct associations between physical activity and commonly investigated sociodemographic variables, thus helping to fill a gap in the literature[12].

Limitations

One of the limitations of the present study is the use of the long form of the IPAQ, which has been shown to overestimate self-reported physical activity[49]. However, it is important to highlight that the IPAQ has also been found to be a reliable and valid tool for population studies[10], providing an internationally comparable measure of physical activity and thus making it highly recommended[50]. Another limitation is that cross-sectional studies are limited in their ability to determine the cause-and-effect relationship between variables.

Collaborations

JF Rodrigues Neto and ALS Guimarães participated in study conception; JF Rodrigues Neto, ALS Guimarães, TCR Martins, GG Pena and RRV Silva developed the study; JF Rodrigues Neto, TCR Martins, GG Pena, RRV, L Pinho, MFSF Brito and MF Silveira participated in data analysis and interpretation and in drafting the article. All authors critically revised the final version of the article.

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