Original Article

Physical activity and nutritional status of Brazilian children of low socioeconomic status: undernutrition and overweight

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The aim of this study was to analyse the level of habitual physical activity (HPA) and nutritional status of children attending selected public schools in Brazil. The sample comprised 1719 participants who ranged in age from 11 to 14 yrs with 861 females (F) aged 12.7±1.0yr and 858 males (M) aged 12.7±1.0yr. The short form of the International Physical Activity Questionnaire (IPAQ) was used to measure HPA. Nutritional status was assessed using the body mass index (BMI). Statistical analyses included ANOVA followed by the post-hoc Tukey-test ($P < 0.05$) which showed a statistically significant difference between M and F in time spent in moderate intensity physical activity. F completed more moderate intensity physical activity than M whereas time in vigorous physical activities was higher in M than F. Analyses of BMI and IPAQ categorical score using Pearson product moment correlations with subsequent Fisher Z transformation showed values of Z = 0.49 for females and Z = 0.44 for males, indicating a low relationship between these variables. HPA levels showed 93.7% of the M and 91.1% of the F were at least minimally active. According to BMI values, 7.3% of the cohort was underweight; 83.0% normal weight; 8.3% overweight and 1.3% obese. These results demand attention, particularly for children at the lower end of nutritional status and HPA levels due to the potential negative impact on their growth and development. At the other end of the nutritional spectrum, one needs to be concerned regarding the levels of excess body weight, mainly considering the poor region in which the children live.

Key Words: child, physical activity, nutritional status, obesity, overweight, socioeconomic factors, Brazil.

Introduction

Many studies have addressed the importance of increasing habitual physical activity (HPA) in populations where low levels of HPA are significantly related to the development of chronic diseases.[1-6] Socioeconomic status and physical activity among adults is inversely associated in developed countries[7], but little is known about the physical activity habits of people who live in developing countries. Of particular interest is the HPA of children and adolescents from very low social levels however very few studies have addressed this issue. In addition, numerous methodological challenges exist in the development of appropriate measurement instruments for such analyses.

While reliability coefficients of children's self-report questionnaires reported in the literature are usually high[8,9] a drawback in the validation of self-report instruments has been the lack of a gold standard measure of physical activity.[8,10] Despite these shortcomings there are many advantages of the self-report instrument including the capacity for administration in large populations and the maintenance of participants' usual activity.[11-13] A number of studies have assessed the physical activity level of Brazilian adolescents using questionnaires.[14-18] Matsudo[18] assessed the validity and reliability of the International Physical Activity Questionnaire (IPAQ) in Brazil and found similar values as for other questionnaires used in the measurement of HPA. A further reported strength of IPAQ is the validity of the questionnaire to predict energy expenditure. The prevalence of obesity is increasing world-wide, including in developing countries such as Brazil where high rates of undernutrition have also been reported.[19] Traditional explanations for the increase in obesity include reduced physical activity and consumption of high fat diets. Further, as traditionally poor countries develop there is a trend for individuals living in rural areas to migrate to urban districts. This is also associated with a reduction in physical activity and is therefore a further risk factor for obesity.[20]

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A relatively new phenomenon in developing countries such as Brazil is the combination of underweight in children and overweight in adults, frequently coexisting in the same family.[21] In Latin America, 40% of families live in extreme poverty and malnutrition is the largest source of illness and premature death in this region.[22] For example in Sao Paulo, Brazil, 30% of children living in shantytowns are malnourished[23] and a study of children aged 6 and 14 years in Cuba reported that 16.7% were undernourished.[24] The choice of a nutritional and/or physical activity instrument depends on the nature of the study, its capacity to provide a realistic indication of the social setting in Latin America, and cost-effectiveness to administer. Recognising the portability of the IPAQ instrument, the objective of this study was to analyse the level of HPA and nutritional status of children attending selected public schools in Brazil. However, most of these studies were of small to moderate sample sizes, and thus the clinical effectiveness of ST is not accepted throughout the medical community.

Materials and methods

Participants

The sample comprised 1719 children attending public schools in several cities in the northern area of Minas Gerais State, a region in which the Brazilian government launched the project, 'Zero misery.' Participants ranged in age from 11 to 14 years, with 861 females (F) (mean age = 12.7yr; SD = 1.0) and 858 males (M) (mean age = 12.7yr; SD = 1.1). All procedures had the support of school Principals and the authorisation of parents or caregivers, with the anonymity of all participants guaranteed.

Study design

All measurements were administered during physical education classes in the first evaluation of the school year, between February and March 2003, by a trained team of physical education teachers.

Anthropometric measurements

Relative weight status was assessed using the body mass index (BMI). Calibrated portable scales were used to measure weight while participants were wearing lightweight clothing and no shoes. Height was measured with a metal tape while participants were barefoot with their head in the Frankfort plane. All measurements were performed during morning hours. Classifications for overweight and obesity were based on the values defined by Cole *et al*.,[25] and the limits for underweight were based on the NCHS[26] recommendations.

Habitual physical activity measurement

The instrument used to measure HPA was the short form (version 8) of the International Physical Activity Questionnaire (IPAQ) (Annex 1).[27] The IPAQ was developed as a standardised instrument for use in a range of populations and therefore allows for comparative analyses between study cohorts. The validity and reliability of the instrument was tested in 14 research centres in 12 countries (Australia, South Africa, Brazil, Canada, United States, Finland, Guatemala, England, Italy, Japan, Portugal and Sweden) in populations aged between 15 and 69 years.

In the present study a modified version of the IPAQ was used to estimate habitual physical activity in younger adolescents, a means of initial screening in a population of very low socioeconomic status. There is a plethora of self- or proxy-report measures of physical activity for young people however there is no internationally accepted standard for the measurement of physical activity in children.[28] In short, despite the wide variety of field methods available no single measure has proven valid, reliable, and logistically feasible. One of the additional challenges is that alternative scoring protocols make it very difficult to compare results between studies. Many children have a limited ability to recall all episodes of activity, accurately report duration and intensity, and sometimes misunderstand concepts being measured. However, the modified form of administration and period of clarification used in this study helped to reduce these problems.

The IPAQ was applied during an interview because there is evidence that interview measures have stronger psychometric characteristics than self-administered measures[29], specifically when considering the 'last week' of physical activity. Three weeks prior to the administration of the IPAQ physical education teachers asked children to take notes about their daily physical activity and bring this information to the next class for comment.

Table 1. Descriptive data.

	Male	Female
N	858	861
Age (yr)	12.7 (1.0)	12.7 (1.1)
Height (cm)	153 (0.1)	1.54 (0.1)
Weight (kg)	43.8 (10.3)	44.4 (8.6)
BMI (kg/m^2)	18.4 (2.8)	18.6 (2.7)

BMI = Body Mass Index

During this three week period knowledge regarding a number of the important terms used in the instrument was standardised. For example, terms such as exercise, physical activity, intensity of activity (low, moderate and vigorous), leisure-time, domestic activities, work-related and transport-related time was explained. This helped to ensure that children had an unambiguous understanding of the types of activities to be assessed by each IPAQ item, along with practical examples in the course of physical education classes. The IPAQ short form assesses physical activity undertaken across a comprehensive set of domains including leisure time, domestic activities, work-related and transport-related time and sitting. The

Table 2. Differences between IPAQ categorical score by BMI, age and gender

IPAQ categorical scores	NW x UW	NW x OW	OW x UW
walking MET-min.week	11-13y-f*	13y-f*	11-13y-f*
moderate MET-min.week	11y-f*	11y-m*	11-12y-m*
vigorous MET-min.week	12-13y-m*		

* P<0.05; y = years; f = female; m = male
NW = Normal weight; UW – Underweight; OW = Overweight;

Table 3. BMI categories distribution by gender and age.

	Underweight				Normal weight				Overweight				Obesity			
Age (yr)	11	12	13	14	11	12	13	14	11	12	13	14	11	12	13	14
Male	9.9	8.0	10.6	6.1	80.9	77.3	79.6	88.6	8.4	12.9	8.1	4.5	0.8	1.6	1.7	0.8
Female	4.5	8.2	3.4	4.3	82.6	80.1	90.2	86.1	9.0	1.1	6.4	7.8	3.9	3.9	0.0	1.7

specific types of activity that are assessed are walking, moderate-intensity activities and vigorous intensity activities. Frequency (measured in days per week) and duration (time per day) were collected for each specific type of activity. The items were structured to provide separate scores on walking; moderate-intensity; and vigorous-intensity activities as well as a combined total score to describe overall level of activity. Computation of the total score required summation of the duration (in minutes) and frequency (days) of walking, moderate-intensity and vigorous-intensity activity. The MET values and formulae for computation of MET-minutes were derived from the IPAQ validity and reliability study.[30] The three formulae are:

1. Walking MET-minutes/week = 3.3*walking minutes*walking days
2. Moderate MET-minutes/week = 4.0*moderate-intensity activity minutes*moderate days
3. Vigorous MET-minutes/week = 8.0*vigorous-intensity activity minutes*vigorous-intensity days.

Data management and analysis

Analysis of variance (ANOVA) was used to identify significant differences between gender and each IPAQ categorical score (inactive, minimally active and health-enhancing physical activity (*HEPA*) active). Statistically significant differences were accepted at a probability level of 0.05. Post-hoc comparisons were used to identify the location of differences by Tukey's test. To verify differences in walking MET-minute/week, moderate MET-minute/week and vigorous MET-minute/week between BMI categories (underweight, normal weight and overweight) *T-test* was used by age and gender. *Pearson product moment* correlations were used to analyse BMI and IPAQ categorical score relationships by gender, with subsequent *Fisher Z transformation.*

Results

Descriptive data are shown in Table 1. Results in relation to HPA showed that 6.3% of males and 8.9% of females were inactive; 46.4% of males and 48.7% of females were minimally active; and 47.3% of males and 42.4% of females were classified as HEPA active. Differences among IPAQ categorical scores by BMI categories, age and gender are shown in table 2 only where a significant difference (P<0.05) was found.

Analyses showed a statistically significant difference between males and females in the following variables: moderate MET-min.week (P<0.05) with females completing more moderate activities than males; vigorous MET-min.week (P<0.05) with males higher than females. In relation to BMI categories values by gender and age are shown as percentages in table 3 and distribution by gender of the total sample in table 4.

Analyses of BMI and IPAQ categorical score using *Pearson product moment* correlations with subsequent *Fisher Z transformation* showed values of Z = 0.49 for females and Z = 0.44 for males.

Discussion

As is the case in many countries, there are no secular trend data on patterns of physical activity in Brazilian children.[31] Results of the present study showed that males are engaged in more vigorous physical activity than females and normal weight boys of 11-12 and 13yrs spend more time in vigorous activities than their under-weight and overweight counterparts. Despite this difference, girls completed more moderate physical activity than males. Further, normal weight girls of 11 and 13 years of age spent more time in moderate intensity and walking activities than their underweight and overweight counterparts. However, when considering the combined percentage of participation in moderate plus vigorous activity, males as a group were more active than females. This finding is consistent with an earlier study of Brazilian children[32] which reported that girls devoted less time to intensely vigorous games than boys and that girls had lower total energy expenditure. Similarly, Black *et al.*,[33] in an analysis of 574 doubly labelled water measurements from multiple investigators verified that normalised values for total energy expenditure were 11% lower in women and girls than in men and boys across the life span. These observations do not resolve the issue of whether the low energy expenditure of the prepubertal girls can be attributed to the natural consequence of sex-related differences in energetic physiology or whether undesirable cultural factors were involved, such as less time spent in vigorous games such as soccer.[32]

Table 4. BMI category distribution by gender

	Under-weight	Normal weight	Over-weight	Obesity
Male	9.6	80.5	8.5	1.3
Female	5.0	85.4	8.2	1.4

The majority of the participants in the current study (M = 93.7%; F = 91.1%) reported levels of physical activity at least minimally active. However, 6.3% of the males and 8.9% of the females were inactive. This level of inactivity is particularly concerning given the age of the sample and recognising that the development of obesity during prepuberal years is generally a slow and gradual process.[34] Higher levels of participation in physical activity can provide greater health benefits however there is no consensus regarding the exact amount of physical activity for maximal health benefits, particularly in children. Low levels of physical activity can have a significant impact on the risk of becoming obese and in undernourished children, perhaps the limited availability of nutrients affects their motivation for involvement in habitual physical activity, allowing the body to preserve its scarce resources.

Analyses of nutritional status found that 9.7% of males and 5.0% of females in our study were underweight. These results were consistent with data from the 1997 survey undertaken by the Brazilian Agency which found that 10.6% of males and 6.5% of females respectively, were underweight.[35] The scope of the present study did not include a consideration of association between macronutrient ingestion, physical activity levels and growth. However, because the level of habitual physical activity for undernourished children can have a negative impact on their growth and physical development, further research is warranted in undernourished groups.

Previous studies have suggested that undernutrition early in life may promote obesity later in life, thus contributing to the escalating prevalence of obesity in developing countries.[35-38] Generalised behaviour patterns developed during early childhood tend to persist over time; thus patterns of opportunistic overeating developed during prolonged periods of undernutrition necessary to cause stunting may represent at least one component of the explanation. Children with insufficient access to quality food and a low degree of food security may be affected by the inability to exercise free expression of their choice in the quality and quantity of food, increasing the risk of overeating, and leading to obesity when environmental conditions are favourable.[37,38] Caballero[21] cited an interesting scenario regarding 'fetal origins of disease hypothesis' where the fetus of an undernourished mother will respond to a reduced energy supply by switching on genes that optimise energy conservation. This survival strategy may cause a permanent differentiation of regulatory systems that result in an excess accumulation of energy when the adult is exposed to an unrestricted dietary energy supply.

At the other end of the nutritional spectrum one needs to be concerned regarding the levels of excess weight in this cohort (namely M = 9.8% and F = 9.5%). These average values are lower than those reported in the 1997 survey where overweight in males represented 13.1% (SD = 0.91) and females 14.8% (SD = 0.97).[33] Levels of obesity, M = 1.4% and F = 1.3%, are lower than the obesity prevalence in boys (6.4%) and girls (8.7%) living in shanty-towns in Sao Paulo.[23] People living in shanty-towns in Sao Paulo, the most economically active city in Brazil, habitually move from rural areas, and have an inadequate income. The urban environment may not offer the safety net of an extended family and subsistence agriculture that is common in rural areas with individuals losing the ability to grow their own food and becoming dependent for their calories on a cash market.[21] These findings are consistent with the literature, from industrialised countries where children in lower socioeconomic groups are at greatest risk. In contrast, there is a higher prevalence of obesity in higher income sectors of the population in developing countries, and among urban populations rather than rural settings[5] and the prevalence of underweight in Brazil is greater in rural than urban areas.[33]

In the United States, increasing energy intake has paralleled the rising prevalence of obesity since 1980[39] suggesting that increased energy intake is likely to be an important underlying factor in the increased number of overweight and obese individuals. Similar trends in energy intake have not been reported in Brazil. Rather, a comparison of national food intake surveys revealed a decrease, rather than an increase, in mean caloric consumption in all regions.[40] Wang *et al.*,[35] found a similar average annual increase in the prevalence of overweight between Brazil and United States indicating that the rapid increases in late childhood and adolescent obesity found in the United States is not restricted to high-income countries. In addition, the study of Monteiro *et al.*,[41] identified an 11% decrease in nationwide daily per capita food availability in Brazil. If the availability of food has decreased and our sample is from one of the poorest regions of the country, how we can explain this number of children with excess weight? Recently, Drewnowski and Specter[42] suggested that the selection of energy-dense foods by food-insecure or low income consumers may represent a deliberate strategy to save money and that persons attempting to limit food costs will first select less expensive but more energy-dense foods to maintain dietary energy. Although nutrient density is particularly important for growing children, cheap, energy-dense, nutrient-poor foods may adversely affect the growth of the child but may provide sufficient calories for the adult to gain excess weight.[21] In this way the association between obesity and poverty may be linked to the low cost of energy-dense foods and their over-consumption. The suggestion that prices influence food consumption choices is shared by the World Health Assembly,[43] and by the study of French *et al*.,[44] who indicated that switches from less healthy to more healthy choices are strongly influenced by pricing factors, and when the price advantages are removed, the purchase preferences for healthier foods disappear.

An interesting finding in the present study was the inverse correlations between BMI and walking MET-minute/week in 14 year-old overweight (r = -0.52) and underweight (r = -0.51) females. This result showed that in our sample, 14 year-old overweight females do not walk less than their leaner counterparts, despite the ambulation, whereby body weight is supported and translocated, is associated with substantial excursions in energy expenditure.[45] These results can be explained if we considered the social context of those participants and that the walking commonly represents the largest component of daily physical activity, mainly as a means of transportation.

It is also interesting to note that in overweight males in the 14 year-old group, the strongest correlations were between BMI (r = 0.74) and body mass (r = 0.75) with vigorous MET-minute/week. The results of these correlations can be explained partially by the commencement of puberty and the related hormonal alterations that promote the increase of lean body mass which influences total body mass. As body fat mass is inert and not highly metabolically active, an excess promotes an increment in work load when considering a common intensity of activity among participants with different levels of body fat.

An increment in work load due to excess body fat can affect the sensitivity to perception of effort among obese individuals and thereby affect answers to questions used to assess levels of HPA. The influence of lean body mass on BMI results is an inherent limitation that should be considered when applied in adolescents.

Despite these findings about 14 years-old males and females, analyses of BMI and IPAQ categorical score using *Pearson product moment* correlation with subsequently *Fisher Z transformation* showed poor Z values (Z = 0,49 for females and Z = 0,44 for males), indicating a low relationship between BMI categories and IPAQ scores. Traditionally, obesity has been linked with abundance[21] and the escalating rate of obesity has been discussed in terms of biology, physiology, and behaviour; the discussion needs to include the role of economics and social policy. We can cite an interesting phrase by Drewnowski and Specter[42] "…people are not poor by choice and they become obese primarily because they are poor…"

Although questions remain about the extent to which anthropometric measurements can predict body fatness in previously malnourished or obese individuals from epidemiologic studies, the data from the current study are consistent with previous studies[21,46,47] and with the fact that Brazil is slightly richer but much more unequal. The United Nations Millennium Declaration recognises that economic growth is limited unless people are healthy.[43] To change this situation and partly solve the inequality, a growth rate in per capita consumption of 2.5% per annum is required to reduce by half the proportion living on less than $US 1 a day, and 3% for the proportion living below $US2 a day[48] based on the poverty line of $US1 per day calculated by researchers at the World Bank. Solutions to the obesity epidemic will in part require that healthy food be accessible and affordable, and this require our engagement not only as health professionals but citizens.[49]

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Appendix

International Physical Activity Questionnaire

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at school, at your home, at streets, to get from place to place, and in your spare time for recreation, exercise or sport. Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like competitive games, fast running or fast bicycling? _____ days per week

(___) No vigorous physical activities *Skip to question 3*

2. How much time did you usually spend doing vigorous physical activities on one of those days? _____ hours per day _____ minutes per day _____ Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or playing not competitive sports? Do not include walking. _____ days per week

(___) No moderate physical activities *Skip to question 5*

4. How much time did you usually spend doing moderate physical activities on one of those days? _____ hours per day _____ minutes per day _____ Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at home, at school, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? _____ days per week (___) No walking *Skip to question 7*

6. How much time did you usually spend walking on one of those days?

_____ hours per day _____ minutes per day _____Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at school, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, playing games with friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day _____ minutes per day _____ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

Original Article

Item non-responses in mailed food frequency questionnaires in a Korean male cancer cohort study

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在一项韩国男性癌症队列研究中邮寄给予食物频率调查问卷存在的未应答项情况

流行病学研究采用邮寄方式给予受试者食物频率调查问卷，时常会遇到未应答项的情况。韩国一项关于男性癌症的队列研究，调查了食物频率调查问卷中未应答项对假定的营养素摄入量和病人分类的影响。一份半定量食物频率调查问卷邮寄给汉城年龄在40到59岁的男性。在14533位参与者中，7647位一次性完成了食物频率调查问卷，216位在再次调查中补充回答了原来的未应答项。当未应答项按照摄入量为零来处理时，该组人群平均营养素摄入量会显著低于一次性完成问卷和在再次调查中完成问卷的人群的平均摄入量。在再次调查中营养素摄入量的增加实质上和原先未应答项的数目成比例。原始调查和再次调查后，以营养素摄入量对未应答人群进行交叉分类，对低值区间块会出现误分类。
此外，再调查组回答为“从不或很少”的分布和一次性就完成问卷的组相似。
这些结果表明，当估计营养素摄入量或以营养素摄入量为基础将受试者分类时，将未应答项以摄入量为零计会导致偏差。如何最好地处理食物频率调查问卷中未应答项还需要更多的研究。

关键词：交叉分类，食物频率调查问卷，未应答项，邮寄。