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J Epidemiol Community Health published online 24 Aug 2009;
doi:10.1136/jech.2009.088526

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Short Title: Decline in physical activity in Brazil

Key-words: motor activity; population surveillance; comparative study; exercise.

Competing Interest: None declared.

Abstract

Background: To document changes in physical activity of Brazilian adults by comparing two surveys carried out five years apart.

Methods: Two population-based cross-sectional surveys were carried out in the city of Pelotas, Brazil, in 2002 and 2007. Their multi-stage sampling strategies were virtually identical. The first study included 3,182 and the second 2,986 adults aged 20 years or older. The short version of the International Physical Activity Questionnaire (IPAQ) was used in both surveys, and individuals were classified as insufficiently active if reporting less than 150 minutes per week, according to a score combining moderate and vigorous-intensity physical activity.

Results: Prevalence of insufficient physical activity increased from 41.1% (95%CI 37.4; 44.9) in 2002 to 52.0% (95%CI 49.1; 53.8) in 2007. A 70% increase in prevalence of insufficient physical activity (p=0.008) was observed among poor individuals, whereas there was no significant change in the better-off. In contrast to the direct association between insufficient physical activity and socioeconomic level found in 2002, the 2007 survey showed no association. In the 2007 multivariable analysis, insufficient physical activity was directly associated with age and inversely with schooling.

Conclusion: Effective interventions for the promotion of physical activity are urgently required in order to overcome the decline in physical activity levels in this population, particularly among the poor.

What is already known on this subject?

There is a wide body of evidence suggesting that physical activity levels are low worldwide, but data on changes over time are lacking. Most studies so far were carried out in Europe, North America and Australia, and very little is known on changes in physical activity levels in low and middle-income countries.

What this paper adds?

Based on data from two population-based surveys carried out five years apart (2002 and 2007) in Southern Brazil, we showed that the proportion of individuals practicing less than the recommended 150 minutes per week of moderate to vigorous physical activity increased from 41 to 52%. This increase was markedly greater among poor people.

Introduction

Surveillance of risk factors for complex chronic diseases is essential in the context of primary health care. Information on time trends with respect to risk factors may guide the planning of effective interventions. Physical activity surveillance is one of the priorities in public health, given the compelling body of evidence linking sedentary lifestyles to unhealthy outcomes [1, 2]. A crucial aspect of surveillance studies is the comparability of methods over time. In the field of physical activity, differences in instruments, cut-off points, physical activity definitions, and domains of activity investigated pose special challenges to surveillance studies.

Cross-sectional studies invariably show high rates of sedentary lifestyle at the population level, regardless of age group or of the country's level of development [3, 4]. Of particular concern are studies showing declines in adolescent physical activity [5] and fitness [6], which likely contribute to the global obesity epidemic [7, 8].

Studies of time trends in physical activity among adults have been carried out mostly in developed countries, and their results indicate that while leisure-time physical activity levels appear to be increasing [9, 10], levels of occupational physical activity seem to be declining [11]. Overall, activity levels still fall short of public health goals[12]. In low and middle-income countries, data on time trends in physical activity are virtually non-existent, as shown by a recent systematic review [13]. No data on this subject were found for Brazil or Latin America.

In 2002, we carried out a physical activity survey among adults resident in Pelotas, southern Brazil [3]. Over the past five years, no specific intervention aimed at increasing physical

activity levels at the population level was implemented in this city. The aim of our study was to document changes in physical activity of Brazilian adults by comparing two surveys carried out five years apart.

Methods

The present analyses rely on two cross-sectional surveys carried out in 2002 and 2007 in the city of Pelotas, Southern Brazil (population 340,000 inhabitants). Detailed information on the methods used in the 2002 survey is available elsewhere [3], and only relevant methodological aspects for the comparison with the 2007 survey are presented here. The first survey was carried out in the late summer and early fall, and the second in the late spring and early summer – both periods have similar temperatures. Sampling strategies were virtually identical in both surveys. The primary sampling units were 126 out of 404 city's census tracts (delimited areas with approximately 300 households each). These areas were systematically sampled taking into account tract size. Census tracts were sorted according to mean schooling level of household heads; therefore, the systematic approach guaranteed stratification by socioeconomic status. Within each sampled tract, on average 11 households were systematically selected. All residents in the sampled households aged 20 years or older were eligible for participation, with the exception of those unable to answer the questionnaire due to severe physical or mental impairment.

In the 2007 survey, 1,460 households were visited, and 2,986 individuals aged 20 years or older interviewed. The overall non-response rate was 6.1%. Non-response was slightly higher among men than women (8.6% vs. 4.7% respectively). Table 1 compares the 2002 and 2007 studies in terms of survey characteristics and of descriptive information. Missing values were uncommon in both studies; 31 participants had no information on socioeconomic level in

2007; missing values were less frequent for all other variables. Complete physical activity data were available for 3,119 people in 2002 and 2,969 in 2007.

Both surveys investigated several health-related outcomes and exposures. Questions on physical activity were included within multipurpose questionnaires, each comprising approximately 200 items. Physical activity questions were placed at the beginning of both questionnaires.

In both surveys, physical activity was measured using the short version of the International Physical Activity Questionnaire (IPAQ). Six questions were used for generating the physical activity score – number of days in the last week and duration per day of walking and physical activity of moderate and vigorous intensity. All domains of physical activity – leisure-time, occupational, housework, and transportation are addressed by the short IPAQ, but questions are not specific to each domain. Only activities practiced for at least 10 consecutive minutes were recalled. As in 2002, we generated a physical activity score, by adding (a) min/wk of walking, (b) min/wk of moderate-intensity physical activity and (c) min/wk of vigorous-intensity physical activity multiplied by two [3, 14-16]. This score is in accordance with the recommended levels of physical activity for adults; 30 minutes of moderate-intensity physical activity at least five days per week and/or 20 minutes of vigorous-intensity physical activity at least three days per week [17]. In both surveys, data were collected by means of face-to-face interviews, carried out by trained female interviewers with at least secondary education. In order to ensure the quality of the data collected, field supervisors revisited 10% of interviewees and administered a short version of the questionnaire. We considered as non-responders individuals who were not located after at least four visits by different field workers. There was no replacement of non-responders.

Participants with scores below 150 minutes were classified as insufficiently active. The independent variables included sex, age (in decades), socioeconomic status (based on the Brazilian Market Research Criterion[18], which divides families into five groups – from A (richest) to E (poorest), and schooling (number of school years completed with approval). In the 2007 sample, families belonging to the richest socioeconomic group had a median monthly income of US$ 2890, compared to US$ 350 among the poorest. All independent variables were collected using exactly the same questions used in the 2002 survey, and categories were also identical to those used in 2002. The following question was also included in the 2007 survey: *"Within the previous five years, has your physical activity level (exercise and sports) increased, decreased, or remained the same?"*

Sample size calculations refer to the comparison of the 2002 and the 2007 surveys. The prevalence of insufficient physical activity in 2002 was 41%. Assuming a confidence level of 95% and 80% power, and including an additional 10% to compensate for non-response, a sample size of 3,000 individuals was needed for detecting as statistically significant differences of 4.5 percentage points or more. This sample had sufficient power to study, within the 2007 database, the association between insufficient physical activity and the four independent variables.

Initial data analyses included a comparison over time of the frequency of independent variables and a description of survey characteristics. We also calculated the prevalence of insufficient physical activity in both surveys across subgroups of the independent variables. Statistical significance was calculated using chi-squared tests for heterogeneity. In multivariable analyses, we used Poisson regression models, as suggested for binary outcomes with high prevalence.[19] The effect of each variable on insufficient physical activity is

adjusted for all other variables. Linear regression, using the physical activity score as the outcome variable, and age (in years) as the exposure, was employed in order to detect what is the increase in the prevalence of insufficient physical activity for each increasing year of age. All analyses were carried out using Stata software and took into account the clustering of the sample, by using the *svy* group of commands.

The study protocols were approved by the Ethics Committee of the Federal University of Pelotas Medical School, and written informed consent was obtained from each responder prior to data collection. Confidentiality was ensured.

Results

In 2007, but not in 2002, insufficient physical activity was more frequent among women than men (Table 2). A direct association with age was seen in both surveys; elderly individuals (70 years or older) showed the highest prevalence. Regarding schooling, those with no formal education showed the highest prevalence of insufficient physical activity in both years.

Prevalence of insufficient physical activity increased from 41.1% (95%CI 37.4; 44.9) in 2002 to 52.0% (95%CI 49.1; 53.8) in 2007. Over the five-year period, prevalence increased significantly in most subgroups analyzed (Table 2). However, the magnitude of the difference varied considerably among subgroups, and was not statistically significant for young adults or for the two wealthiest socioeconomic groups (A and B). Whereas prevalence of insufficient physical activity increased by 70% over five years among the poor, the increase among the rich was of only 8%, reversing the social gradient observed in 2002 (Figure 1).

After adjustment for confounders (Table 3), the difference between the sexes was no longer statistically significant. The unadjusted associations with age, schooling and socioeconomic position remained after controlling for confounders, in both surveys.

Regarding the additional question on the perception of change in level of physical activity over the five-year period, 42.8% of participants reported physical activity levels similar to those of five years earlier, 35.9% reported a reduction in physical activity, and 21.3% an increase. Through regression analyses of the 2007 data, a five-year increase in age was associated with an increase of 4.5 percentage points in the prevalence of sedentary lifestyle.

Discussion

This study was not aimed at testing an intervention. Although there were local and state initiatives for promoting physical activity in parts of Brazil [20, 21], none of these reached the study area. Other determinants of physical activity remained unchanged over the last five years, including the city environment – safety, traffic issues – and access to physical activity facilities. Therefore, we are confident that our findings reflect underlying time trends in physical activity, rather than the effect of any given interventions.

The increase in prevalence of insufficient physical activity over the five-year period – 41% to 52% – has several implications for public health. Such a rapid increase may have a series of long-lasting impacts on health, including increased risk of obesity, coronary heart disease, diabetes, hypertension, depression, and other diseases [22]. Physical activity involves four main domains: leisure time, occupation, transportation and housework. Because the short IPAQ does not discriminate among these domains, we are not able to determine which

domain(s) account for the observed reduction. Nevertheless, based on the international literature and on our analyses, it is possible to speculate about the reasons for this decline. In our study, the poor tended to become more sedentary over time, whereas there was no significant increase was observed among the rich. This is likely due to a combination of three separate trends. As described for high-income countries [23, 24], physical effort at work is decreasing rapidly in Brazil along with economic development; this would contribute to less activity among the poor, who tend to be manual laborers. Likewise, use of mechanized transportation among the poor seems to be growing. A rapid increase in purchasing power among the poor has resulted in a sharp increase in the use of motorcycles and car; although we have no data to confirm this trend in Pelotas, the number of vehicles on the streets has increased sharply. This would contribute to a decline in transportation-related physical activity. Cross-sectional Brazilian studies suggest that levels of leisure-time physical activity among the poor are very low [25, 26]. Therefore, declines in occupational and transportation-related physical activity, rather than a reduction in leisure-time activity are likely to explain the overall reduction among the poor.

Whereas changes in occupation and transportation may contribute to less activity among the poor, there was no overall change among the rich in this five-year period. In Europe [11, 27], and to a lesser extent in the United States[12], leisure-time physical activity appears to be on the rise in recent years. A cross-sectional study carried out in our city showed that rich are more likely than the poor to emulate high-income country patterns of leisure-time activities [28], but the lack of a clear time trend in the present analyses suggests that these changes are not yet measurable.

When results are stratified by schooling instead of wealth, individuals with no schooling showed the highest prevalence of insufficient physical activity, as was the case five years ago. Schooling and socioeconomic level are strongly correlated, although previous Brazilian studies on other health outcomes indicate that these two variables may have different effects [29]. In our analyses, poverty and high schooling were associated with greater physical activity in 2002; by 2007, high schooling continued to be associated with greater activity, but the association with wealth reversed and lost statistical significance. If these trends continue, one may expect both wealth and schooling to be directly associated with activity, reproducing in the future the patterns that are currently observed in high-income countries.

In both surveys, older adults showed the highest prevalence of insufficient physical activity. Pro-activity campaigns should consider the particularities of this age group, especially given the rapid ageing of the Brazilian population and the consequent increase in the health needs of the elderly. The literature shows that physical activity interventions targeting older adults are more likely to be successful, given the higher adherence rates among this age group when compared to younger interviewees [30]. Two methodological aspects should also be considered when discussing the association between physical activity and age. First, few studies of time trends in physical activity among older adults are available worldwide. Second, most physical activity questionnaires have an upper age threshold, limiting their use on older adults. Although the original IPAQ is recommended up to the age of 65 years, we used it for all ages in both surveys, given that the long IPAQ leisure-time section had been validated for older adults in Brazil [31].

The low levels of physical activity observed in both surveys have several possible explanations. First, there is lack of access to physical activity facilities, particularly after

working hours. Second, prescription of physical activity in governmental health services that cover 80% of the Pelotas population is still uncommon. Third, there are no structured mass education or promotion campaigns at the local, state, regional, or national level, although the importance of exercise for health is a frequent subject in the media. Qualitative studies suggest that this contributes to making individuals guilty [32] for not practicing physical activity, but at the same time the system is not conducive for supporting the recommended levels of exercise. Finally public spaces for the practice of exercise are very rare in the city, particularly in low-income settings.

Several studies from different settings investigated physical activity at the community level. Given the wide range of definitions, instruments, cut-off points, and domains of activity evaluated, comparison of results across investigations remains a challenge [33]. An advantage of the present study is the high degree of methodological comparability between the two surveys. This included details such as placing the physical activity questions near the beginning of both questionnaires, to avoid potential bias arising from the fact that respondents may become tired after answering to a large number of questions. Also, the same instrument – the short IPAQ – was used in both assessments. Validation studies show that use of different questionnaires, or even of different versions of the IPAQ, can lead to inconsistent findings [34, 35]. Seasonality may also affect the comparability of physical activity levels [36]. Field work for both surveys took place during periods of the year that were similar in terms of temperature and humidity (end of Summer-early Fall and end of Spring-early Summer).

In summary, our study shows that physical activity levels are declining in a Southern Brazilian adult population. This finding highlights the need for physical activity interventions

in the Brazilian context. Environmental changes are urgent, since safe and pleasant public spaces for physical activity are uncommon; changes in transport policy and creation of useable green space in urban areas should be prioritized. Such changes could impact on physical activity levels of individuals from all socioeconomic groups. Local interventions should be implemented and evaluated, and if applicable expanded to other settings. Inclusion of exercise professionals in the public health system is another possible approach, as suggested by previous research [37]. Special attention should be paid to the huge increase in insufficient physical activity among the poor. Finally, repeated surveys in the same geographical area are important for monitoring time trends and assessing the effectiveness of present and future interventions.

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Table 1. Comparison between the 2002 and 2007 surveys on physical activity (PA) among adults. Pelotas, Brazil.

Indicator	**2002 survey**	**2007 survey**
Number of households visited	1,530	1,460
Number of eligible people	3,372	3,180
Non-response rate	5.6%	6.1%
Total sample size	3,182	2,986
Participants with missing PA score (%)	63 (2.0%)	17 (0.6%)
Sample size for PA analyses	3,119	2,969
% males	43.2%	43.1%
	(95%CI 41.5 - 44.9)	(95%CI 41.3 - 44.8)
Mean age (SD)	44.0 (16.3)	44.7 (17.0)
% of individuals with no schooling	7.0%	6.4%
	(95%CI 6.1 - 7.9)	(95%CI 5.5 - 7.3)
% smokers	27.9%	25.7%
	(95%CI 26.3 - 29.4)	(95%CI 24.2 - 27.3)
% obesity (body mass index $\geq$ 30 kg/m^2)	14.3%	16.6%
	(95%CI 13.1 - 15.6)	(95%CI 15.2 - 18.0)
% reporting “poor” health status	4.0%	5.1%
	(95%CI 3.3 - 4.6)	(95%CI 4.3 - 5.9)

Table 2. Prevalence of insufficient physical activity (IPA) according to independent variables in two surveys carried out five years apart. Pelotas, Brazil.

Variable	2002 survey		2007 survey		%	
	% IPA	*P**	*% IPA*	*P**	**change**	*P#*
Sex		0.47		0.02		
Males	40.2		49.5		+23	<0.001
Females	41.8		54.0		+30	<0.001
Age (years)		<0.001		<0.001		
20-29	39.4		44.8		+14	0.09
30-39	37.0		47.9		+30	0.003
40-49	37.8		49.1		+30	0.003
50-59	39.7		53.3		+35	<0.001
60-69	43.8		57.3		+31	0.008
70 or more	64.7		76.3		+18	0.01
Schooling (years)		<0.001		<0.001		
0	56.7		72.0		+26	0.008
1-4	40.6		57.0		+40	<0.001
5-8	36.6		49.5		+35	<0.001
9-11	41.6		48.6		+17	0.03
12 or +	44.1		49.6		+12	0.008
Socioeconomic level		0.01		0.82		
A (richest)	46.9		50.6		+8	0.55
B	47.8		52.2		+9	0.23
C	41.0		51.5		+26	<0.001
D	37.2		52.8		+42	<0.001
E (poorest)	35.7		60.7		+70	0.008

* Chi-square test for differences in proportions

\# Chi-square test for differences in proportions over time within each subgroup

Table 3. Adjusted prevalence ratios[#] for insufficient physical activity in the sub-groups of the independent variables in two surveys carried out five years apart. Pelotas, Brazil.

Variable	**2002 survey**		**2007 survey**	
	PR (95%CI)	*P**	*PR (95%CI)*	*P**
Sex		0.88		0.08
Males	1.00		1.00	
Females	1.01 (0.90 – 1.13)		1.07 (0.99 – 1.15)	
Age (years)		<0.001		<0.001
20-29	1.00		1.00	
30-39	0.93 (0.81 – 1.07)		1.06 (0.93 – 1.21)	
40-49	0.94 (0.80 – 1.10)		1.09 (0.98 – 1.21)	
50-59	0.97 (0.83 – 1.15)		1.18 (1.10 – 1.32)	
60-69	1.08 (0.88 – 1.32)		1.23 (1.10 – 1.41)	
70 or more	1.53 (1.28 – 1.82)		1.63 (1.43 – 1.85)	
Schooling (years)		0.003		0.005
0	1.36 (1.08 - 1.70)		1.23 (1.04 - 1.45)	
1-4	1.04 (0.86 - 1.26)		1.04 (0.90 - 1.20)	
5-8	0.96 (0.80 - 1.15)		0.98 (0.86 - 1.11)	
9-11	1.02 (0.87 - 1.20)		1.02 (0.91 - 1.20)	
12 or +	1.00		1.00	
Socioeconomic level		0.008		0.54
A (richest)	1.00		1.00	
B	1.01 (0.79 – 1.28)		1.02 (0.83 – 1.25)	
C	0.85 (0.66 – 1.08)		1.00 (0.82 – 1.23)	
D	0.73 (0.55 – 0.98)		0.96 (0.77 – 1. 19)	
E (poorest)	0.65 (0.46 – 0.92)		1.18 (0.85 – 1.65)	

[#] The effect of each variable on sedentary lifestyle is adjusted for all other variables

* Wald test for heterogeneity

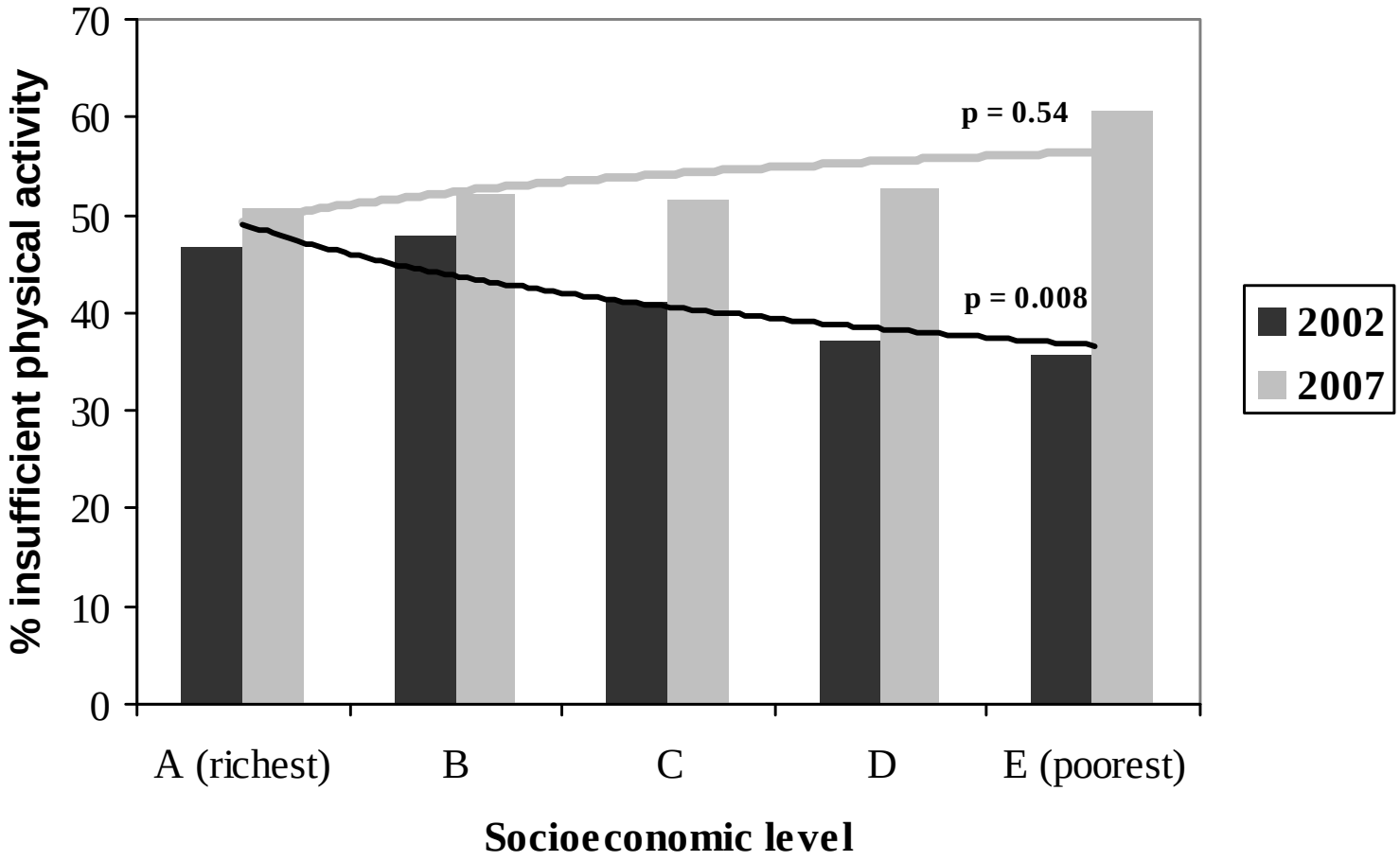

Figure 1. Prevalence of insufficient physical activity according to socioeconomic status in two surveys carried out five years apart. Pelotas, Brazil.