


BMJ Open Physical activity patterns in a representative sample of adolescents from the largest city in Latin America: a cross-sectional study in Sao Paulo

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To cite: Ferrari G, Rezende LFM, Wagner GA, et al. Physical activity patterns in a representative sample of adolescents from the largest city in Latin America: a cross-sectional study in Sao Paulo. *BMJ Open* 2020;**10**:e037290. doi:10.1136/bmjopen-2020-037290

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2020-037290>).

Received 28 January 2020
Revised 18 June 2020
Accepted 13 July 2020



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ABSTRACT

Objectives We examined the patterns of total and domain-specific physical activity (PA) by sex, socioeconomic status and maternal education level in adolescents from Sao Paulo city, Brazil.

Design Cross-sectional study.

Participants We included a representative sample of 2682 (52.2% boys) adolescents aged 14–15 years from public and private schools in Sao Paulo, 2017. Socioeconomic status was assessed using a wealth index derived from principal component analysis. Descriptive analyses evaluated differences in total and domain-specific PA by sex, socioeconomic status and maternal education level.

Outcome measures We collected data on the frequency and duration that adolescents spent in each PA domain (active transportation, leisure PA and physical education classes) through a self-report questionnaire.

Results On average, adolescents spent 197.7 min/week (95% CI 190.6–204.8) in total PA. The proportion of adolescents achieving at least 60 min/day (≥ 420 min/week) was 12.7% (95% CI 11.4–14.1), with a higher prevalence in boys (18.3%) and in those with higher socioeconomic status (17.4%). Similar patterns were observed for leisure PA and physical education classes. Active transportation was higher in girls (46.0 min/week; 95% CI 42.6–49.6) than in boys (43.4 min/week, 95% CI 39.9–46.6). Boys and adolescents with higher socioeconomic status and higher maternal education level had higher levels of total PA.

Conclusions We found a variation in patterns of total and domain-specific PA by sex, socioeconomic status and maternal education level in adolescents from Sao Paulo. Initiatives for promoting PA in adolescents should take these findings into account.

INTRODUCTION

The health benefits of physical activity (PA) during childhood and adolescence are well known. PA decreases the risk of cardiovascular disease and adiposity and improves cognitive development and cardiorespiratory and muscular fitness.¹ In addition, PA during adolescence has been linked to a lower risk

Strengths and limitations of this study

- Use of a large sample of adolescents living in a megacity, Sao Paulo; therefore, the representativeness is high.
- Use of total and domain-specific physical activity (PA) data to describe adolescent's PA patterns by sex, socioeconomic status and maternal education level.
- PA was collected through a self-report questionnaire; therefore, measurement error is likely to have occurred.
- Out-of-school adolescents were not included in our study.
- Approximately 1 out of 10 adolescents did not report maternal education level.

of non-communicable diseases during adulthood.² To achieve these health benefits, the WHO recommends that adolescents accumulate at least 60 min/day of moderate-to-vigorous intensity PA (MVPA).³ In Brazil, only 29% of adolescents meet these PA guidelines, a scenario that is slightly better than the world average (19%).⁴ The reasons for this low PA level in adolescents are not yet fully understood.⁵

In relation to a large number of correlates and determinants of PA, evidence has shown that some population strata have greater opportunities to achieve the recommended PA guidelines.⁶ A systematic review showed that young people with socioeconomic vulnerability have lower levels of PA.⁷ In Brazil, the National School-Based Health Survey (*Pesquisa Nacional de Saúde do Escolar - PeNSE*) showed that boys and children of mothers with more years of schooling are more active in their leisure time than girls and adolescents of mothers with incomplete elementary school.⁸

An emerging area of research is the context in which PA occurs, also known as domains or modes of PA.¹ PA includes a diversity of organised (eg, sports activities and physical education classes) and unorganised activities (eg, active play or unorganised sport), as well as active transportation (eg, cycling to school).¹ Assessing the patterns of total and domain-specific PA may provide a more complete understanding of this complex behaviour. For instance, perceived traffic and access to recreational and leisure facilities have been positively associated with engagement in sports. In contrast, the presence of adequate walking and cycling infrastructure, street connectivity and proximity to public spaces have been associated with increased active transportation.⁹ These findings suggest that PA determinants may differ according to PA domains.^{10 11}

Promoting PA in adolescents living in megacities is an even greater challenge. Sao Paulo is among the 10 most urbanised and populous cities in the world,¹² characterised by diverse cultural and socioeconomic backgrounds, as well as wide variation in disease distribution and lifestyles. In the last years, Sao Paulo has undergone an accelerated urbanisation process, along with a demographic, epidemiological and socioeconomic transition.¹³ Meanwhile, highly disorganised and heavy traffic, air and noise pollution, rising crime rates and high-income inequality persist in this megacity.¹³ These changes have produced changes in PA patterns in all age groups.^{14 15} Systematic reviews indicated that most studies have been conducted in high-income countries.^{16 17} In Brazil, previous studies have suggested that socioeconomic inequalities in access to leisure PA have decreased between 2009 and 2015, although it remains high.¹⁸ In addition, few studies have shown the pattern of total and domain-specific PA in adolescents living in megacities in low-income to middle-income countries.¹⁹

In the urban context of Sao Paulo, characterised by social fragmentation and inequalities in opportunities to engage in PA, the New Master Plan has emerged as an effective initiative to promote active life.²⁰ This initiative improved an extensive network of bike paths created in Sao Paulo in 2014. In the last 5 years, the number of bike lanes has increased particularly in this city. This can be partly explained by the fact that bike lanes allow the temporary and regular use of public open spaces in urban contexts where there is relatively low availability of public recreation facilities and public spaces. Furthermore, bike lanes represent an opportunity to encourage the equitable and sustainable use of public spaces, as they have the potential to change transportation behaviours.²¹ Therefore, understanding the patterns of total and domain-specific PA by sex, socioeconomic status and maternal education can provide new insights and enable future research on how policies and interventions impact PA in adolescents. To describe the PA pattern in adolescents in Sao Paulo, we used data from a large representative sample of students, the Sao Paulo Project for the Social Development of Children and Adolescents (*São Paulo para o desenvolvimento social de crianças e adolescentes* - SP-PROSO).

METHODS

Study design, sample and data collection

SP-PROSO is a cross-sectional study including a representative sample of ninth-grade students from public and private schools in Sao Paulo, 2017.²² The schools' principal, responsible guardian and the adolescents themselves signed a consent form to participate in the study.

The target population included ninth-grade adolescents formally enrolled in schools in the city of Sao Paulo. According to the 2015 School Census, a total of 175 854 students were enrolled in the ninth grade of 2086 private and public schools in Sao Paulo. The minimum sample size was determined to obtain estimates of population groups of at least 15% of the population ($n = n_0 / 0.15$), with an accuracy of (d) 0.06 and a sampling design effect of 1.7. The estimated minimum sample size was 2849 students. Considering a possible loss of 10%, this number was increased to 3300. The sampling strategy considered stratification by school type (state public, municipal public and private) and clustering by considering each class as a drawing unit. In total, 156 classes were randomly selected and 119 schools agreed to participate in the study. Of the 61 private schools drawn, 26 refused to participate and 3 did not respond to our invitation and were excluded. Of the public schools, there was only one loss among the state schools and seven among the municipal schools. Regarding the students, considering the number that attended classes on the day of data collection ($n = 2816$), 96 were not authorised by their parents or refused to participate in the study and 18 could not participate due to health-related and/or reading/comprehension issues. The final sample size was 2702 participants, which represented 94.8% of the calculated minimum sample size.

Adolescents filled out a self-report structured questionnaire available in their classrooms during regular school hours. The questionnaire was based on two validated questionnaires from the Global School-Based Student Health Survey²³ and the Youth Risk Behaviour Surveillance System.²⁴

PA assessment

The PA questionnaire asked participants about their weekly frequency and duration of active transportation (walking or cycling) to and from school, leisure PA and participation in physical education classes during the past week. This questionnaire has been used by the National Survey of School Health.²⁵ Measures of PA have been validated previously and showed satisfactory relative validity (sensitivity: 77.9%; specificity: 69.1%; accuracy index: 73.1%).²⁶

We calculated total PA by summing the minutes per week (min/week) of each PA domain. Adolescents were categorised as 'meeting' (≥ 420 min/week) or 'not meeting' (< 420 min/week) PA guidelines according to WHO's recommendations for adolescents.³ PA in each domain was expressed as continuous (min/week) and categorical (participation in at least 2 days a week). Finally, we estimated the distribution of total PA according to PA

domains (ie, to estimate the share of each PA domain in total PA).

Sociodemographic variables

The socioeconomic status was determined based on maternal education level and a series of questions that explored the possession of goods and the presence of a maid in the home. These questions were derived from the PeNSE. The PeNSE questionnaire included questions about the presence of goods in the home (the home where the adolescents actually lived). This questionnaire and method of measuring socioeconomic status have been widely used in Brazilian school surveys.²⁷

As previously suggested by Barros and Victoria, the socioeconomic status was calculated through principal component analysis (PCA).²⁷ PCA was ran adding to the model: maternal educational level (incomplete middle school, complete middle school, complete high school and complete higher education); school type (public or private); landline (yes or no), mobile phone (yes or no), internet computer in the room (yes or no), car (yes or no) and number of bathrooms inside the house. The first component of the PCA and estimated coefficients were obtained using the following equation: coefficient= $\text{loading}/\text{SD}\times 100$. The individual value was calculated from $\sum c_i v_i$, where c_i is the coefficient and v_i is the score for the i th variable. Socioeconomic status was categorised as tercile of the total wealth scores, being the first tercile the poorest group and the third tercile the wealthiest group. Total and domain-specific PA were also presented separately by sex and maternal education level.

Patient and public involvement

This cross-sectional study with adolescents did not involve patients in the design, recruitment, implementation or planning.

Statistical analysis

Total and domain-specific PA were described using absolute frequencies, mean (and its 95% confidence intervals - CI) and median (and its interquartile range - IQR). Analyses were carried out according to sex, socioeconomic status and maternal education level. Mann-Whitney and Kruskal-Wallis tests were used to compare means and variances, and the X^2 test was used to compare categorical variables. All analyses were performed using IBM SPSS (V.22, IBM Corp).²⁸

RESULTS

On average, adolescents spent 197.7min (95% CI 190.6–204.8) in total PA per week, with a median value of 140min/week (IQR: 55.0–280.0) (figure 1). Boys, adolescents with higher socioeconomic status and higher maternal education level presented higher levels of total PA. Mean differences in total PA were: 82min/week higher in boys than girls; 57min/week higher in those of high socioeconomic status compared with those of low

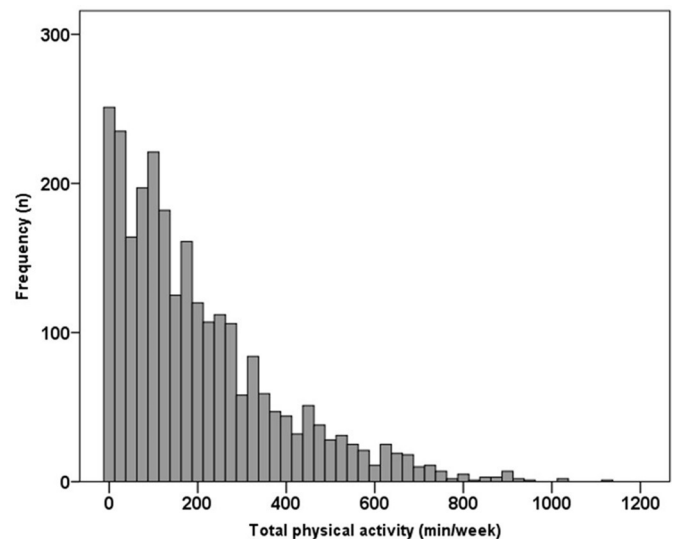


Figure 1 Distribution of total physical activity (min/week) in adolescents from Sao Paulo city, SP-PROSO, 2017.

socioeconomic status; 21 min/week higher in those whose mothers had complete higher education compared with those whose mothers did not complete middle school. The proportion of adolescents achieving ≥ 420 min/week of total PA was 12.7% (95% CI 11.4–14.1), with a higher proportion in boys (18.3%) than in girls (6.8%), in the high socioeconomic group (17.4%) than in the low socioeconomic group (9.0%), and in those whose mothers completed higher education (16.0%) than in those whose mothers did not complete middle school (14.5%) (table 1).

Figure 2 shows the proportion of adolescents participating in at least 2 days/week in each of the three PA domains investigated: 65.2% for active transportation, 63.7% for leisure PA and 81.2% for participation in physical education classes.

Figure 3 displays the proportion of each domain-specific PA to total PA by sex, socioeconomic status, maternal education level and PA guidelines. The relative contribution of leisure PA was higher among adolescents with higher levels of PA. For instance, leisure PA contributed to 46.1% of total PA in boys, 49.5% in adolescents with high socioeconomic status, 46.2% in adolescents whose mothers completed high school and 55.7% in adolescents achieving PA guidelines.

In absolute terms, leisure PA contributed more to total PA in boys (112.7min/week), in adolescents with high socioeconomic status (116.1min/week) and in those whose mothers completed high school (106.0min/week). In contrast, active transportation contributed more to total PA in girls (46.0min/week). Physical education classes had a higher share of total PA in boys (92.3min/week), in adolescents with high socioeconomic status (76.8min/week) and in those whose mothers did not complete high school (83.7min/week) (figure 4).

Table 1 Sociodemographic characteristics associated with total physical activity in adolescents from Sao Paulo city. SP-PROSO, 2017.

Variables	N	%	Mean (95% CI)	Median (25–75)	≥420 min/week (95% CI)	P value†
Total	2682		197.7 (190.6–204.8)	140.0 (55.0–280.0)	12.7 (11.4–14.1)	
Sex	261					<0.001
Boys	1363	52.2	238.2 (227.6–248.8)	180.5 (25.0–343.7)	18.3 (16.4–20.5)	
Girls	1247	47.8	155.8 (146.2–164.9)	105.0 (30.0–225.0)	6.8 (5.2–8.1)	
Socioeconomic status	2682					
Low	893	33.3	173.0 (161.7–185.3)	120.0 (45.0–255.0)	9.0 (7.3–10.8)	<0.001
Middle	890	33.2	197.8 (185.2–210.8)	140.0 (70.0–275.0)	12.5 (10.3–14.7)	
High	899	33.5	230.1 (217.2–243.9)	190.0 (85.0–330.0)	17.4 (15.0–19.9)	
Maternal education level	1855					
Did not complete middle school	462	24.9	206.5 (187.4–226.7)	140.0 (50.0–303.7)	14.5 (11.4–17.9)	0.093
Complete middle school	366	19.7	186.6 (167.8–206.0)	130.0 (60.0–240.0)	9.8 (6.7–13.0)	
Complete high school	715	38.5	208.1 (194.1–221.3)	165.0 (75.0–305.0)	14.1 (11.5–16.8)	
Complete higher education	312	16.8	227.9 (205.9–250.9)	175.0 (76.2–340.0)	16.0 (12.4–20.4)	

*² test.

DISCUSSION

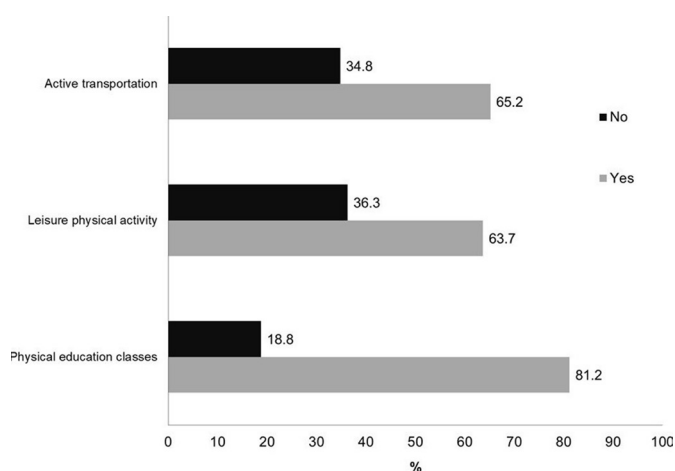
The aim of this study was to describe the patterns of total and domain-specific PA by sex, socioeconomic status and maternal education level in adolescents from the largest city of Latin America, Sao Paulo. On average, adolescents spent 197.7 min/week in total PA. The proportion of adolescents who met the PA recommendations (≥420 min/week) was 12.7% and was higher in boys and adolescents with higher socioeconomic status. Active transport contributed more to total PA in girls than in boys (29% vs 18%). Leisure PA and physical education classes were higher in boys and adolescents with high socioeconomic status. Boys with higher socioeconomic status and maternal education had higher levels of total PA.

Children and adolescents aged 5–17 years are advised to accumulate at least 60 min of daily MVPA (≥420 min/

week).³ Compared with high-income countries, we found a higher prevalence of insufficient PA in adolescents in Sao Paulo (87.3%) than in adolescents in Australia (83.5%), USA (70.9%), Denmark (80.4%) and Spain (74.4%). Worldwide, 81% of adolescents aged 11–17 years do not achieve this goal.⁴ In other Brazilian cities, the proportion of adolescents that do not meet the PA guidelines is lower than in Sao Paulo; eg, 60% in Distrito Federal, 63.2% in Rio de Janeiro and 64.1% in Rio Grande do Sul.²⁹ These differences in PA across countries and cities are not well characterised. Heterogeneity across countries in terms of socioeconomic and environmental determinants of PA domains could certainly play a role.⁴ Intervention programmes should consider PA patterns to encourage PA practice among adolescents in the city of Sao Paulo.

Sao Paulo has been described as a city with a large disorganised urban sprawl. In the past 70 years, there has been an increase in violence and a decrease in public open spaces in peripheral regions and in low socioeconomic areas. These facts may explain the higher prevalence of physical inactivity among adolescents in Sao Paulo compared with other cities. However, in the last 10 years, different interventions have aimed to change this scenario. The New Master Plan to reduce environmental inequities was implemented in 2014.²⁰ Thereafter, programmes such as ‘ruas de lazer’ were implemented, where streets are closed to cars and open to the population on weekends. There was also an increase in bike paths and programmes such as ‘ciclofaixas de lazer’, where part of the streets and avenues are open to cyclists on weekends. Finally, green areas such as squares and parks around the city have also been expanded and valued as important public spaces for PA.²¹

In our study, patterns of domain-specific PA were different between boys and girls. Active transportation

**Figure 2** Proportion (%) of adolescents practising physical activity at least 2 days per week by domain of physical activity. SP-PROSO, 2017.

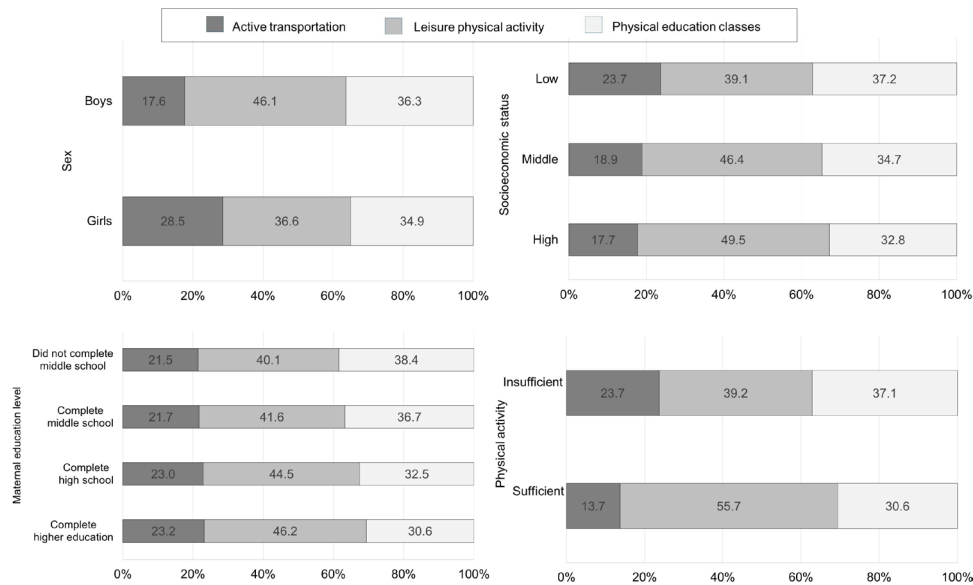


Figure 3 Proportion (%) of domains of physical activity by sex, socioeconomic status, maternal education level and physical activity guidelines. SP-PROSO, 2017

was higher, in absolute and relative terms, in girls than in boys. In contrast, boys were more active than girls in the domains of leisure and physical education classes. These findings are similar to previous studies conducted worldwide.^{4 30} In addition, the contribution of leisure PA and physical education classes to total PA was found to be 46.1% and 36.3% in boys and 36.6% and 34.9% in girls, respectively. Boys tend to participate more frequently in high-intensity PA (eg, soccer, basketball, volleyball), whereas girls tend to engage in light to moderate-intensity activities, such as walking and water activities.³¹ In addition, boys report greater social support from parents and friends, have fewer barriers to getting involved in and a greater perception of self-efficacy for PA. In contrast, girls show more negative attitudes towards PA, refer to more barriers and perceive less favourable environments for PA.³² PA interventions, especially in leisure time, are important to increase the total PA of adolescent girls in Sao Paulo. For this reason, it is imperative to identify girls' preferences, reasons and barriers to participate in these activities.

Adolescents with a high socioeconomic status showed a higher PA level than the lower socioeconomic groups. Higher socioeconomic status has been associated with more opportunities at school and in the community for PA.⁷ Similarly, our results showed that adolescents with a higher maternal education level tend to have higher levels of total PA, especially in the leisure PA domain, possibly reflecting a higher socioeconomic status. Several methods have been used to determine the socioeconomic status (eg, family income, professional occupation, parental education and place of residence), which have been shown to influence adolescent PA in particular ways.⁷ For example, while the poorest groups walk more to and from school or work and develop more household activities, wealthiest groups engage more frequently in leisure

PA, which could be explained by differences in access to financial and material resources. Different mechanisms may explain the relationship between parental education and PA.⁷ First, participation in many types of PA has financial costs (eg, purchasing equipment, monthly fees and transportation) that may not be affordable by the poorest families.³³ Families with higher socioeconomic status usually live in neighbourhoods with better infrastructure for PA (eg, parks, squares, running/walking tracks or cycle paths). In addition, adults with higher education levels have higher PA levels, particularly during leisure time,^{34 35} which may positively influence adolescents' PA.^{1 3} Another plausible explanation for this association is that physically active parents are more likely to provide greater social support for adolescent PA.^{1 36}

In our study, adolescents spent relatively little time on leisure PA and active transportation. Participants did, on average, 93 min/week of leisure PA and 44 min/week of active transportation. These domains accounted for only 23% and 41% of total PA, respectively. Active transportation to school is an important source of PA and has been associated with higher PA levels in adolescents.^{37–39} As only 65% of the participants engage in active transportation, school-based interventions aiming to promote walking or cycling to and from school are needed. Prevalences of active transportation in Latin American countries have been associated with different socioenvironmental characteristics.⁴⁰ Safety, social support for commuting and the built environment have been reported to be important determinants of active transportation in adolescents.⁴¹

Physical education classes are a fundamental opportunity to promote PA.^{10 42} Physical education classes may contribute considerably to adolescent PA, both directly, by offering PA in the class, and indirectly, by stimulating PA practice, favouring access to knowledge

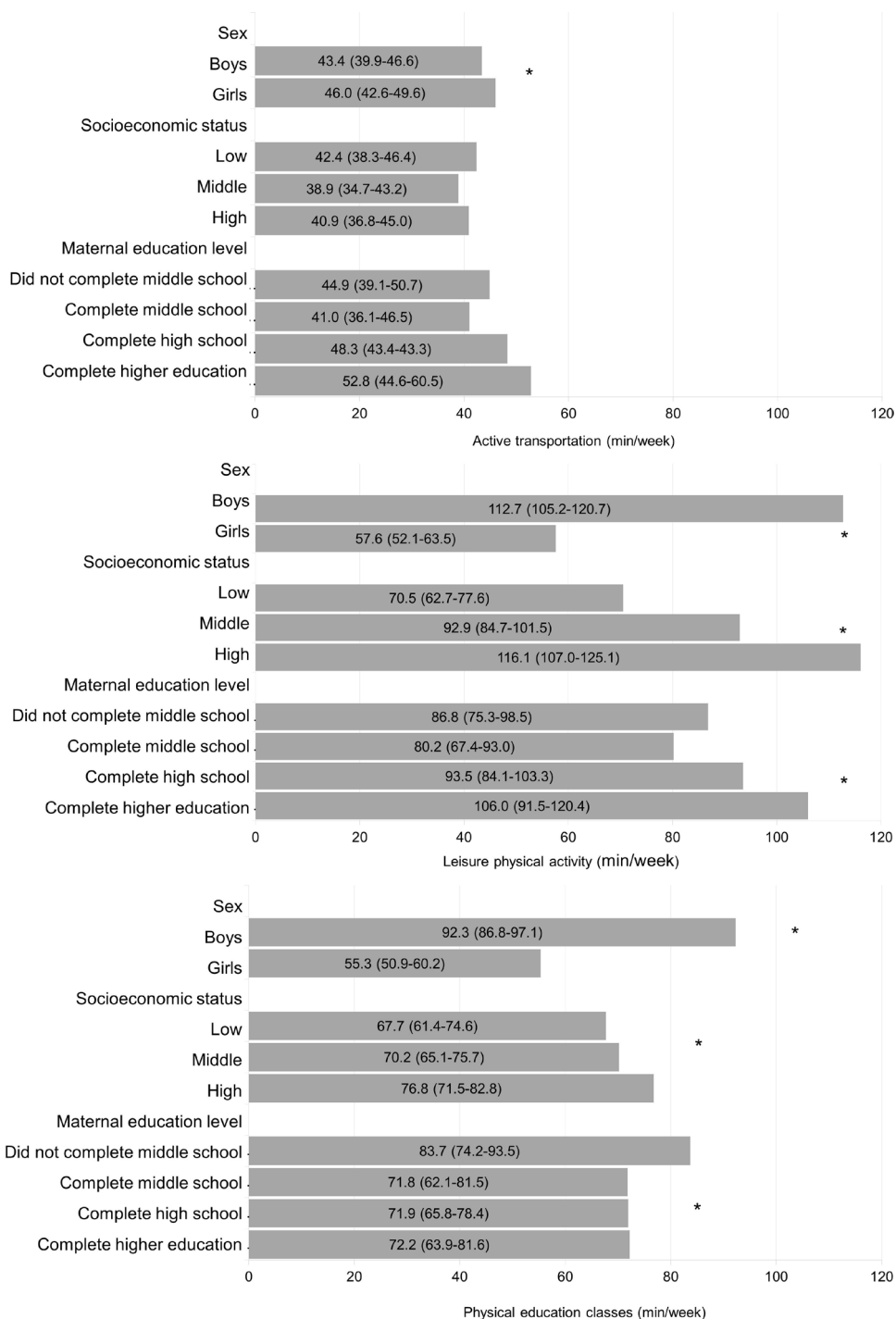


Figure 4 Domains of physical activity in minutes/week (mean and 95% CI) by sex, socioeconomic status and maternal education level. * $P < 0.05$.

and positive experiences with PA.⁴² A systematic review that estimated PA levels during physical education classes showed that, on average, youth spend 37% of their physical education time in MVPA.⁴³ In another study, physical education classes contributed 30% to total PA.³⁸ Adolescents who participate in physical education classes are more likely to be physically active.⁴²⁻⁴⁴ Physical education classes showed to be an important opportunity for adolescents' PA, especially for those with lower socioeconomic status and lower

maternal education level. Policies aimed to promote PA should ensure, among other things, that frequency and quality physical education classes contribute to adolescents develop standards of behaviours that keep them physically active throughout their lives.⁴⁵

Patterns of total and domain-specific PA may be useful for decision makers to plan and promote PA interventions. Decisions can be made to construct appropriate PA leisure environments, such as outdoor park courts,⁴⁶ and improve the walkability of streets²⁶

and cycle paths. Our results indicate that adolescents participating in leisure PA are more likely to achieve PA guidelines. In this sense, schools and decision makers should prioritise PA programmes focused on leisure activities to increase total PA in adolescents in Sao Paulo.

Our study has some limitations. Of the 61 private schools drawn, 26 refused and 3 did not respond, so they were excluded. Of the public schools, one state school and seven municipal schools were lost. Out-of-school adolescents were not included in our study. PA information was collected through a self-report questionnaire, and therefore measurement error probably occurred. Although participants were asked about the frequency and duration of each PA domain in a typical week, the questionnaire did not include information on the intensity of activities.⁴⁷ However, this PA questionnaire has shown high relative accuracy.²⁶ The maternal education variable had substantial missing data (30%). However, missing data were not related to sex and socioeconomic status. Adolescents with missing maternal education data showed similar active transportation and participation in physical education classes. However, they tended to present higher levels of leisure PA (mean: 179.2 min/week; $P < 0.001$) and total PA (mean: 75.2 min/week; $P < 0.001$) compared with those who did answer a questionnaire about maternal education level (data not shown).

CONCLUSIONS

In this study, we found different patterns of total and domain-specific PA by sex, socioeconomic status and maternal education level in adolescents from Sao Paulo. Subgroups of adolescents with higher PA levels (boys and adolescents with high socioeconomic status and high maternal education level) tended to have more engagement in leisure PA. Routine PA transportation should also be highly encouraged to increase PA in adolescents. Future studies should seek to better understand the challenges of implementing and promoting PA by considering total and domain-specific PA patterns.

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Acknowledgements The authors would like to thank the adolescents participating of the SP-PROSO.

Contributors GF and LFMdR had full access to all study data and were responsible for the integrity of the data and the accuracy of the data analysis. The corresponding author had final responsibility for the decision to submit for publication. MFP was the PI responsible for study concept, design and data

collection. GF and LFMdR prepared the first draft. GF, LFMdR, GW, AF and MFP drafted and critically revised the manuscript for important intellectual content and gave final approval of the version to be published.

Funding The present research received financial support from the British Academy/Newton Foundation grant #AF160099), Sao Paulo Research Foundation (FAPESP) grant #2016/22259-4.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval The protocol was approved by the Ethics and Research Committee of the University of Sao Paulo, School of Medicine (Comitê de Ética e Pesquisa da Faculdade de Medicina da Universidade de São Paulo, records no. 1.719.856) and the National Commission for Research Ethics (Comissão Nacional de Ética em Pesquisa (CONEP), records no. 2.014.816).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information. All data relevant to the study are included in the article or uploaded as supplementary information. Data are available upon reasonable request from the corresponding author.

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