



# Secular Trends and Sociodemographic Correlates of Walking among Adolescents in Southern Brazil (2007–2017/2018)

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RESEARCH

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## ABSTRACT

Walking is an important and popular form of physical activity for health, whose trends of decline among Brazilian adolescents over the years remain unknown. The purpose of this study was to analyze the secular trend and sociodemographic correlates of walking among adolescents in southern Brazil (2007–2017/18). Two cross-sectional surveys, conducted in 2007 and 2017/18, gathered data from 1967 adolescents in Florianópolis, Brazil, using a standard protocol. We collected data on the weekly frequency and duration of walking practice. Gender, age, and socioeconomic status (SES) were modeled in logistic regression analysis. Overall, the weekly volume (time) spent walking declined by 43.1% over the years. In all gender, age, and SES subgroups, walking declined from 31.5% to 51.7%. Compared to 2007 adolescents, girls (OR: 4.14; 95% CI: 2.66–6.43), younger adolescents (15 years: OR: 3.23; 95% CI: 1.74–5, 98; 16 years: OR: 4.36; 95% CI: 2.66–7.15) and those with low SES (OR: 3.48; 95% CI: 2.13–5.68) and high SES (OR: 3.39; 95% CI: 2.21–5.20) were the 2017/18 groups most likely to be inactive on the walk. This study reveals a decline in walking among adolescents in southern Brazil, affecting all analyzed sociodemographic groups. Girls, younger adolescents, and individuals from both ends of the socioeconomic spectrum showed higher probabilities of inactivity in this form of physical activity. Targeted public policies aimed at promoting walking and addressing the specific needs of girls, youth, and various socioeconomic groups are necessary.

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## INTRODUCTION

A regularly active population is the foundation of a healthier and more sustainable society. Physical activity (PA) during active commuting aids in the control and prevention of chronic diseases (e.g., heart disease), reduces the consumption of fossil fuels and improves air quality (WHO, 2018). Global estimates show that one in four adults do not follow the minimum PA recommended for health benefits (Guthold et al. 2018). The situation among adolescents is concerning because 81% failing to meet the recommended minimum of 60 minutes of moderate to vigorous PA daily (WHO, 2018, Guthold et al. 2020), with imminent risks of becoming physically inactive adults (Uddin et al. 2020). This highlights the urgency of understanding and addressing declining PA trends, particularly among adolescents.

The benefits derived from PA can be attained through various means, including walking (Oja et al. 2018; Hsu et al. 2021; Adamakis, 2023). Walking is the most popular form of PA, reflecting its accessibility, low or no cost, and being the easiest way for most people to initiate or maintain PA (Ussery et al. 2018). Walking is still important for adolescents as a habit that should be kept throughout life (Hsu et al. 2021), and can be practiced for different purposes such as recreation, transport, leisure, and in various environments (Cerin et al. 2022). The walk was also featured in the Global Action Plan on Physical Activity, as one of the PA that should be promoted to reduce physical inactivity in adolescents by 15% by 2030 (WHO, 2018).

Studies on PA trends published up to 2022 indicate limited evidence regarding walking among adolescents, with the observed declines primarily related to walking as an active commuting to school (Pinto, Marques and Pelegrini, 2023). It is known that traveling the home-school-home route on foot is related to healthier body composition, higher PA levels, and improved cardiorespiratory fitness (Pinto et al. 2018; Henriques-Neto et al. 2020). Nevertheless, trends in the practice of walking for other purposes remain unknown. Studies compiled in a systematic review indicated that boys, younger adolescents, and those from low-income families are more likely to actively commute to school (Pinto et al. 2018). However, these correlates may not be the same as those for general walking.

Continuous monitoring of walking levels in a population can be valuable in identifying the need for adjustments in public policies aimed at achieving the goals of the Global Action Plan on Physical Activity. This information is particularly important given the scarcity of studies on general walking practices among adolescents (Pinto, Marques and Pelegrini, 2023). Given reports indicating alarming levels of physical inactivity among adolescents (Guthold et al. 2020), we hypothesize that there has been a decline in the practice of walking in recent years. Understanding the sociodemographic factors associated with walking offers another tool in tackling the potential public health challenge posed by a decline in adolescent walking and a future rise in chronic diseases.

By examining the sociodemographic correlates of these practices, the study can contribute to current knowledge by providing valuable insights for policymakers to tailor interventions and effectively promote walking among adolescents. This study aims to examine secular trends and sociodemographic correlates of walking practices among adolescents in southern Brazil over a 10-year period.

## METHODS

### STUDY DESIGN AND LOCATION

This is a secular trend study. Possible changes in the practice of walking were analyzed using data collected as part of a research project entitled “Physical activity levels, physical fitness, and social behavior related to adolescent health: a secular trend study.” Data collection was performed from August to December 2007 in Florianópolis, southern Brazil, and repeated in 2017/2018. The two surveys collected cross-sectional information on adolescents aged 15 to 18 years regularly enrolled in state public schools in Florianópolis. Because of logistical issues, data collection at one of the schools included in the 2017 survey was performed from March to May 2018.

Located on the coast of the state of Santa Catarina in southern Brazil, Florianópolis currently has an estimated population of 516,524 residents, spread over its 674.844 km<sup>2</sup> area, with a population density of 729.89 inhabitants/km<sup>2</sup>. The average monthly salary for formal workers

is 4.4 times the minimum wage (approximately \$1143 USD), and the Municipal Human Development Index is 0.847. Further information about the city of Florianópolis can be obtained from the Brazilian Institute of Geography and Statistics (<https://cidades.ibge.gov.br/brasil/sc/florianopolis/panorama>).

## SAMPLE SELECTION

Participants were selected based on school census data from the State Department of Education. The total population of adolescents regularly enrolled in state public schools in 2007 and 2017 comprised 12,741 and 10,192 individuals, respectively. In the two cross-sectional surveys, sampling parameters were as follows (Luiz and Magnanini, 2000): (i) 95% confidence level, (ii) tolerable error of 4 percentage points, and (iii) estimated prevalence of 50% (unknown outcome, prioritizing a large sample number).

To account for potential biases and ensure the final sample size, two adjustments were made. First, the minimum sample size was multiplied by 1.5 to consider the “design effect” (*deff*). This means we expected students within the same school (the “conglomerate”) to be more similar than students from different schools, potentially inflating the variance in our results. This adjustment increases the needed sample size to ensure accurate results despite this clustering effect. Second, an additional 10% was added to the sample size to account for potential losses due to dropouts or ineligibility. This ensures that even after excluding non-participants, the final sample remains large enough for reliable conclusions. Based on these parameters, the final sample consisted of 975 adolescents in 2007 and 992 in 2017/2018.

Based on the first survey, the sample number was proportionally distributed in the five regions of the city (Center, Mainland, East, North, and South) defined by the Municipal Health Department. This distribution was necessary to ensure sample representativeness, avoid regional bias, address potential regional variations, and maximize sample coverage and efficiency. The largest school (in terms of enrolled students) in each region was selected for data collection. The adolescents were selected by drawing the number of classes and lessons required until the minimum quantity was reached for the region (saturation sampling). All adolescents in the selected classes were invited to participate in the research (cluster sampling).

The research protocol and its ethical aspects were approved by the Brazilian National Health Council in 2007 (protocol No. 372/2006) and 2017 (protocol No. 2,172,699). All participants provided written consent themselves or from their parents and/or guardians (for those aged 17 years or younger) to participate in the study. During data screening, entries from adolescents who had physical disabilities or psychological disorders were excluded.

## PROCEDURES AND MEASURES

Data collection was performed by the same researchers in the two surveys (2007 and 2017/2018) to ensure standardized procedures. The presence of the same researchers helps with familiarity with the research question and the population, maintaining standardized procedures and maintaining the continuity and credibility of the project. Trained researchers used the same self-administered questionnaire in both surveys. The information included sociodemographic variables such as sex (girl and boy) and age in complete years (15 to 18 years).

Socioeconomic status (SES) was assessed using the latest version of a national questionnaire in each year. The socioeconomic questionnaire evaluates SES based on, among other information, the number of household items present in the family's residence (<https://www.abep.org/criterio-brasil>). In 2007, questionnaire items included, for example, color television, video cassette player, radio, and fridge. Each item was worth 1 point, and the total score ranged from 0 to 34 points. In 2017/2018, items were updated and included, for example, microwave oven, DVD player, and personal computer, with a total score ranging from 0 to 100 points. The higher the score, the higher the SES. Given the change in questionnaire items and scores, SES was classified into tertiles (first tertile, low; second tertile, medium; third tertile, high).

Walking (dependent variable) was evaluated using the items related to the practice of walking of the International Physical Activity Questionnaire – Short Form (IPAQ-SF), which is recommended for population monitoring (Craig et al. 2003). IPAQ-SF assesses the duration ( $\geq 10$  continuous minutes) and frequency of walking (at home, at work, for travel purposes, for leisure, or as

an exercise) in a usual week. The IPAQ-SF specifically asks about the average number of days per week participants spent walking for at least 10 minutes per session. This captures the frequency of walking activity. The questionnaire further differentiates between moderate-intensity walking (e.g., brisk walking) and vigorous-intensity walking (e.g., fast walking uphill). The instrument showed satisfactory measurement properties to monitor habitual PA levels among Brazilian adolescents aged 14 years or older (Guedes, Lopes and Guedes, 2005). The weekly walking volume (in minutes) was determined by multiplying the frequency (number of days) of walking by the daily duration (Martinez-Gomez et al. 2014). Given the absence of specific guidelines for walking in adolescents, we followed the recommendations for moderate and vigorous PA for this age group (minimum of 60 min daily) (WHO, 2018). Thus, adolescents who did not walk for 60 min or more a day were considered insufficiently active.

## STATISTICAL ANALYSIS

Data were analyzed using descriptive and inferential statistics. The Kolmogorov–Smirnov test assessed the normality of numerical variables and indicated that the data did not follow a normal distribution. Subsequently, the median, interquartile range (IQR), 95% confidence interval (95% CI), and relative frequency (%) were calculated. We used the chi-square test to verify possible differences in subgroup proportions between years. Trends in walking practice were calculated using the Delta Variation ( $\Delta\%$ ): [(final value - initial value)/initial value  $\times$  100]. The proportion of adolescents in each weekly frequency category (days per week) in 2007 and 2017/2018 was compared using a two-tailed Z-test. Differences in the percentage variation of median values of daily and weekly walking time between 2007 and 2017/2018 were assessed using the Mann–Whitney U-test.  $\Delta\%$  and 95% CI values were used to compare the median values of 2007 and 2017/2018 between sex, age, and SES groups. Possible decline trends or increases in walking time were significant if 95% CI did not overlap. Multivariate binary logistics regression was used to verify the highest ratio and the respective 95% CI of the possible declines in each group. For this analysis, insufficient walking (<60 min/day) was the outcome, and surveys (2007 and 2017/2018) were the exposure. All analyses were conducted using IBM SPSS Statistics software version 20.0 (IBM Corp., Armonk, NY, USA). The level of significance was set at  $p < 0.05$ .

## RESULTS

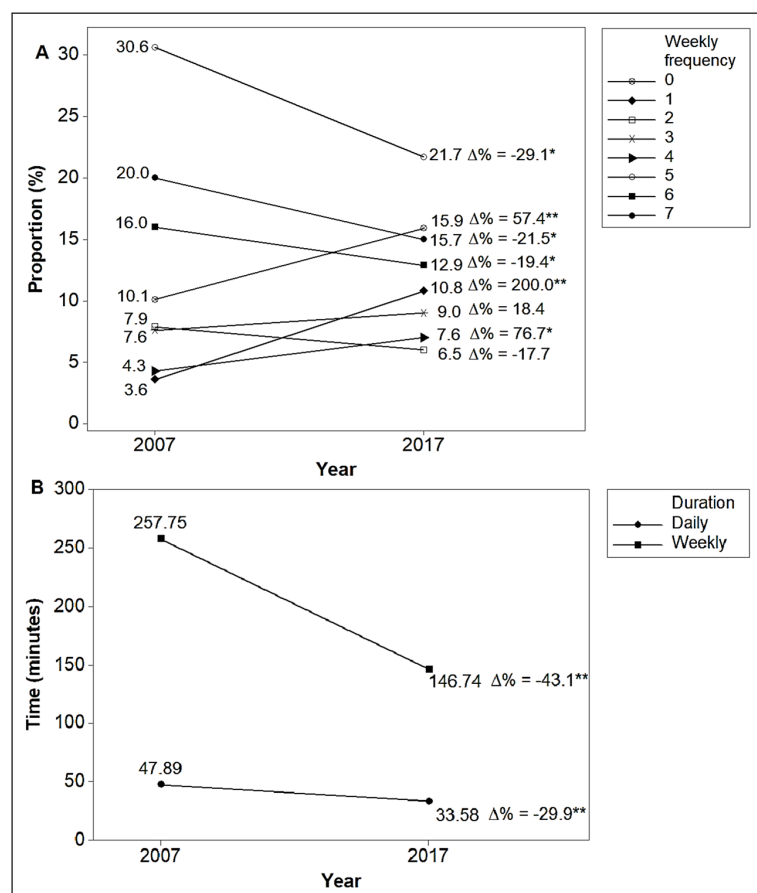
In total, 1967 adolescents provided complete responses to the questionnaire. Most participants were female (54.9%), and the median age was 16.00 years (IQR = 2.00 years). Differences were observed between sex and age with the year of the survey. The frequency distribution of adolescents by sex, age, and socioeconomic level in each survey is presented in Table 1.

VARIABLE	TOTAL	2007	2017/2018	p-VALUE
<b>Total</b>	1967	975 (49.6)	992 (50.4)	0.718*
<b>Sex, n (%)</b>				<0.001*
Female	1080 (54.9)	599 (61.4)	481 (48.5)	
Male	887 (45.1)	376 (38.6)	511 (51.5)	
<b>Age (years), median (IQR)</b>	16.00 (2.00)	16.00 (2.00)	17.00 (1.00)	<0.001†
<b>Age, n (%)</b>				<0.001*
15	523 (26.6)	324 (33.2)	199 (20.1)	
16	607 (30.9)	317 (32.5)	290 (29.2)	
17	626 (31.8)	258 (26.5)	368 (37.1)	
18	211 (10.7)	76 (7.8)	135 (13.6)	
<b>Socioeconomic level, n (%)</b>				<0.133*
Low	639 (32.5)	309 (31.7)	330 (33.3)	
Medium	650 (33.0)	309 (31.7)	341 (34.4)	
High	678 (34.5)	357 (36.6)	321 (32.3)	

**Table 1** General characteristics of study participants (Florianópolis, Brazil).

*Note:* n, absolute frequency; IQR, interquartile range; \*chi-square test; †Mann–Whitney U-test.

A marked reduction in the practice of walking was observed over the analyzed decade (Figure 1). General trends indicated that the proportion of adolescents who do not walk any day of the week increased (57.4%;  $Z = -3.87$ ,  $p < 0.001$ ). Between 2007 and 2017/2018, the proportion of adolescents who walk only a few days per week increased (one day = 200.0%;  $Z = -6.17$ ,  $p < 0.001$ ; four days = 76.7%;  $Z = -3.05$ ,  $p = 0.002$ ). On the other hand, there was a decline in the proportion of adolescents who walk five to seven days per week (five days = -29.1%;  $Z = 4.39$ ,  $p < 0.001$ ; six days = -19.4%;  $Z = 1.95$ ,  $p = 0.05$ ; seven days = -21.5%;  $Z = -2.48$ ,  $p = 0.01$ ). From 2007 to 2017/2018, there was a 29.9% decrease in the daily time spent walking ( $p < 0.001$ ) and a 43.1% decrease in the weekly time spent walking ( $p < 0.001$ ).



**Figure 1** Trends in (A) weekly frequency and (B) total daily and weekly duration of walking in adolescents (2007–2017/2018). \* $p < 0.05$ ; \*\* $p < 0.001$ .

Variations in walking duration by subgroup and regression analysis results are described in Table 2. The total time spent walking reduced significantly in all subgroups, particularly in girls (-44.2%), adolescents aged 16 years (-51.7%), and adolescents with low socioeconomic level (-46.4%). Compared with adolescents in 2007, all in 2017/2018, regardless of the subgroup, were more likely to be physically inactive. At the group level, in 2017/2018, adolescents with the highest probabilities of being inactive in comparison with 2007 were girls (OR 4.14, 95% CI 2.66–6.43), younger adolescents (15 years: OR 3.23, 95% CI 1.74–5.98; 16 years: OR 4.36, 95% CI 2.66–7.15), and individuals with low (OR 3.48, 95% CI 2.13–5.68) or high (OR 3.39, 95% CI 2.21–5.20) socioeconomic level.

## DISCUSSION

This study sought to explore as secular trends and sociodemographic correlates of walking, regardless of the domain of physical activity, in adolescents, acknowledging that prior studies have also noted a decline in adolescents' walking as an active commuting to school. Notably, this study innovates by examining independent groups, shedding light on the relationships between variables and walking behaviors. The study contributes additional information about physical activity patterns in adolescents to the existing literature.

VARIABLE	WALKING DURATION (MIN/WEEK) (95% CI)		Δ (%)	OR* (95% CI)
	2007	2017/2018		
<b>Sex</b>				
Male	277.0 (248.2–305.7)	160.0 (145.4–174.6)	–42.2	2.83 (2.00–4.05)
Female	237.6 (220.1–255.0)	132.6 (119.9–145.3)	–44.2	4.14 (2.66–6.43)
<b>Age (years)</b>				
15	224.9 (200.2–249.5)	126.3 (107.5–145.2)	–43.8	3.23 (1.74–5.98)
16	286.7 (258.7–314–70)	138.5 (121.4–155.6)	–51.7	4.36 (2.66–7.15)
17	256.1 (225.8–286.4)	163.1 (145.5–180.8)	–36.3	2.89 (1.87–4.47)
18	231.3 (225.8–286.4)	149.8 (123.3–176.3)	–31.5	2.73 (1.05–7.06)
<b>Socioeconomic level</b>				
Low	251.3 (224.6–278.0)	134.8 (117.5–152.1)	–46.4	3.48 (2.13–5.68)
Medium	233.3 (207.7–259.9)	142.9 (128.2–157.7)	–38.7	3.01 (1.81–4.99)
High	270.8 (243.2–298.4)	163.0 (144.5–181.6)	–39.8	3.39 (2.21–5.20)

**Table 2** Trends in weekly walking time and results of logistic regression for subgroups of sociodemographic correlates of insufficient walking practice among adolescents in Florianópolis, Brazil (2007–2017/2018).

OR, odds ratio; CI, confidence interval. Data from 2007 were used as a reference. \*OR for sex was adjusted for age and socioeconomic level, OR for age was adjusted for sex and socioeconomic level, and OR for socioeconomic level was adjusted for sex and age. All OR values are significant at  $p < 0.001$ .

In the investigated decade (2007–2017/2018), walking time per week declined by 43.1%. At the group level, girls, younger adolescents, and those with low or high socioeconomic levels were more likely to be less active in 2017/2018 than their respective peers in 2007. In practice, the findings indicate that physical inactivity has been gaining ground and manifesting itself in walking, considered the most popular PA in the world (Cesare et al. 2019). Furthermore, the low engagement of some groups in walking is probably causing disparities in PA levels, contributing to a problematic scenario among adolescents (WHO, 2018).

In the period investigated, a significant decline in walking was observed among adolescents, making this group less prone to the benefits of walking, such as improvements in mental health (Hsu et al. 2021), increased energy expenditure (Adamakis, 2023), and higher PA levels (Carlin, Murphy and Gallagher, 2016). Walking trends among adolescents were identified as limited in a systematic review of the secular trends in PA across various domains and contexts, based on articles published until February 2022 (Pinto, Marques and Pelegrini, 2023). This finding is in line with those of studies investigating trends in walking as a form of active commuting to school among adolescents in the Czech Republic (Pavelka et al. 2017), Spain (Chillón et al. 2013), Australia (Salmon et al. 2005), and Brazil (Coll et al. 2014). Unfortunately, the reduction in walking observed here corroborates the decrease in PA in adolescents from several countries (Conger et al. 2022; Pinto, Marques and Pelegrini, 2023), including Brazil (Pinto et al. 2022).

Some factors may explain the decrease in walking due to the broad wide spectrum of opportunities for walking as a PA. First, the increase in the purchasing power of households in the investigated period might have translated into an increase in the acquisition of motor vehicles (Rech et al. 2015), minimizing the walking opportunities of adolescents. Secondly, parents' and children's perceptions of insecurity might have increased over the years, restricting walking to move from one place to another, whether for leisure or transportation. It is noteworthy that the homicide rate in Brazil increased by 24% from 2000 to 2017, being higher in men, young people, Blacks, and poor individuals (Ceccato, Kahn, and Vasquez, 2021). Third, the decline in walking might be related to reducing adolescents' interest in activities involving movement, including walking. A survey conducted with adolescents in southern Brazil revealed increased engagement in screen-based activities from 2001 to 2011 (Bertuol et al. 2019). Fourth, in agreement with the previously mentioned hypotheses, the poor infrastructure of sidewalks and the need to walk long distances might have contributed to the decline in walking among adolescents. Fifth, it's worth considering the suggestion that a diversified range of exercise options could contribute to the decline in adolescent walking. While the aforementioned limiting factors are significant, we hypothesize that the availability of various exercise alternatives might have also influenced adolescents' choices, contributing to the observed decrease in walking.

At the sex level, while both boys and girls were more likely to be insufficiently active in walking in 2017/2018 (compared with 2007), our study reveals a noteworthy finding: the odds of reduced



walking were substantially higher among girls. In 2017/2018, girls exhibited the highest probabilities of inactivity when compared to 2007, with an odds ratio of 4.14 (95% CI 2.66–6.43). This result diverges from a study with adolescents in southern Brazil, showing that girls had greater participation in less intense physical activities such as walking than boys (Ramires et al. 2016). There seems to be a consensus that girls are less active than boys concerning PA in general (Guthold et al. 2020) and are less likely to use walking as a means of active commuting (Salmon et al. 2005; Chillón et al. 2013; Coll et al. 2014; Pavelka et al. 2017; Pinto et al. 2018; Pinto et al. 2020; Pinto et al. 2021). Possible reasons for this association include but are not limited to, the distance to be covered by walking, parents' concerns about the insecurity of walking routes, particularly for girls, and issues related to sweating, which seem to bother girls more than boys (Pinto et al. 2018). Given this, girls may be a target subgroup for interventions focused on increasing PA, particularly walking. Nevertheless, it should not be disregarded that boys are also less active nowadays.

It was identified that, in 2017/2018, younger adolescents (15 and 16 years old) had higher OR values for insufficient walking, in agreement with the literature (Pinto et al. 2018; Uddin, Mandic and Khan, 2019; Villa-González et al. 2019). Although the association between age and walking is unclear (Pinto et al. 2018), it seems to be similar to the relationship between age and PA (Villa-González et al. 2019). The association might be linked to younger adolescents' lower independence and autonomy in lifestyle decisions (Villa-González et al. 2019). For instance, parents tend to restrict the forms of active displacement of their children for various reasons, such as fear of insecurity and greater control over younger children (Pinto et al. 2018; Loureiro et al. 2022). It is believed that such conditions may affect the walking behavior of adolescents. Older adolescents likely have fewer barriers to walking, including longer distances. Although the aforementioned hypotheses are based on studies investigating walking as a means of active displacement, they align with a previous study indicating a 22.8% reduction in the preference of younger adolescents for physical activities from 2001 to 2011 (Bertuol et al. 2019).

Adolescents with low or high socioeconomic levels in 2017/2018, compared with their peers in 2007, had higher OR values for insufficient walking. This result is interesting, as it suggests that socioeconomic level might not influence the decline in walking, given that the greatest declines were observed in opposite strata of socioeconomic levels. It is speculated that this result is related to the time spent walking for specific purposes in each socioeconomic stratum. Adolescents belonging to families with low socioeconomic level tend to be more active while commuting to school than those from higher socioeconomic levels (Pinto et al. 2018). On the other hand, adolescents from families with higher socioeconomic levels are more likely to walk in urban green spaces (e.g., parks, forests, trees, and playgrounds) than those from lower socioeconomic levels (Rehling et al. 2021).

Overall, the greater decline in walking among adolescents from families with low socioeconomic levels might be related to increased purchasing power directed toward motor vehicles (Rech et al. 2015). Therefore, adolescents partake in passive commuting to school (motorized transport), disregarding the opportunity to walk during weekdays (Pinto et al. 2018). Among adolescents from families with high socioeconomic levels, the decline in walking might be related to the use of this activity for leisure (Rehling et al. 2021), issues related to insecurity (Ceccato, Kahn, and Vasquez, 2021), concern about traffic, and poor infrastructure (Buehler, Pucher and Bauman, 2020). The cited factors may explain, to some extent, the decline in walking observed in both groups of socioeconomic level.

The findings need to be considered in light of some limitations. Using a subjective measure of walking time might not be the most appropriate, and inaccuracies in self-reporting cannot be disregarded. The trends observed here apply to adolescents enrolled in public schools. They may not apply to those enrolled in private schools. Furthermore, we do not have data on energy expenditure, walking intensity, or walking speed, which are more important than total walking time for health purposes (Hsu et al. 2021; Adamakis, 2023). Thus, it is impossible to say whether adolescents' energy expenditure in 2017/2018 also decreased. Finally, information on the purpose of walking (e.g., transportation, leisure) was not obtained, impairing analysis of the reasons for decreased walking. Studies have shown that walking behavior may differ according to the purpose of the activity (Ussery et al. 2018).

Despite these limitations, the study's strengths lie in its ability to identify independent groups and their relationships with walking behavior, aiding decision-making processes. Furthermore, the study benefits from a large sample size of adolescents and the use of comparable repeated measures conducted with a rigorous protocol.

## CONCLUSIONS

From 2007 to 2017/2018, the practice of walking declined among adolescents in southern Brazil, possibly suggesting a temporal decline in PA levels specifically related to walking. Girls, younger adolescents, and those with low or high socioeconomic levels were the least active concerning walking in 2017/2018. These findings reveal a worrisome scenario of walking practice in the studied decade. Future studies on walking trends in adolescents should investigate walking intensity and purpose. Creating and improving accessible and safe places for walking may encourage this practice and increase PA among adolescents. Public policies need to promote walking to increase PA levels in adolescents.

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## COMPETING INTERESTS

The authors have no competing interests to declare.

## AUTHOR CONTRIBUTIONS

Conceptualization, A.A.P., and A.P.; methodology, A.M., and A.P.; formal analysis, A.A.P., and A.P.; investigation, A.A.P., and M.A.B; writing the first draft of the manuscript, A.A.P., and M.A.B., review and editing, A.M., and A.P. All authors have read and agreed to the published version of the manuscript.

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## REFERENCES

- Adamakis, M.** (2023). Energy Expenditure of Adolescents During Overground Walking and Running. *Journal of Science in Sport and Exercise*, 5(1), 44–52. DOI: <https://doi.org/10.1007/s42978-021-00157-7>
- Bertuol, C., Silva, K. S., Barbosa Filho, V. C., Bandeira, A. S., Lopes, M. V. V., & Nahas, M. V.** (2019). Preference for leisure activities among adolescents in southern Brazil: What changed after a decade? *Journal of Sports Psychology*, 28, 81–80.
- Buehler, R., Pucher, J., & Bauman, A.** (2020). Physical activity from walking and cycling for daily travel in the United States, 2001–2017: Demographic, socioeconomic, and geographic variation. *Journal of Transport & Health*, 16, 600811. DOI: <https://doi.org/10.1016/j.jth.2019.100811>
- Carlin, A., Murphy, M. H., & Gallagher, A. M.** (2016). Do interventions to increase walking work? A systematic review of interventions in children and adolescents. *Sports Medicine*, 46, 615–530. DOI: <https://doi.org/10.1007/s40279-015-0432-6>



- Ceccato, V., Kahn, T., & Vazquez, L. C.** (2021). Lethal violence in Brazil: A systematic review of Portuguese-language literature from 2000 to 2020. *Criminal Justice Review*, 16(4), 404–434. DOI: <https://doi.org/10.1177/07340168211038273>
- Cerin, E., Salis, J. F., Salvo, D., Hinckson, E., Conway, T. L., Owen, N., van Dyck, D., Lowe, M., Higgs, C., Moudon, A. V., Adams, M. A., Cain, K. L., Christiansen, L. B., Davey, R., Dygrýn, J., Frank, L. D., Reis, R., Sarmiento, O. L., Adlakha, D., Boeing, G., Liu, S., & Giles-Corti, B.** (2022). Determining thresholds for spatial urban design and transport features that support walking to create healthy and sustainable cities: findings from the IPEN Adult study. *The Lancet Global Health*, 10(6), e895–e906. DOI: [https://doi.org/10.1016/S2214-109X\(22\)00068-7](https://doi.org/10.1016/S2214-109X(22)00068-7)
- Cesare, N., Nguyen, Q. C., Grant, C., & Nsoesie, L. O.** (2019). Social media captures demographic and regional physical activity. *BMJ Open Sport Exercise Medicine*, 5(1), e000567. DOI: <https://doi.org/10.1136/bmjsem-2019-000567>
- Chillón, P., Martínez-Gómez, D., Ortega, F. B., Pérez-López, I. J., Díaz, L. E., Veses, A. M., Veiga, O. L., Marcos, A., & Delgado-Fernández, M.** (2013). Six-year trend in active commuting to school in Spanish adolescents: The AVENA and AFINOS studies. *International Journal of Behavior Medicine*, 20(4), 529–537. DOI: <https://doi.org/10.1007/s12529-012-9267-9>
- Coll, C. V. N., Knuth, A. G., Bastos, J. P., Hallal, P. C., & Bertold, A. D.** (2014). Time trends of physical activity among Brazilian adolescents over a 7-year period. *Journal of Adolescent Health*, 54(2), 209–213. DOI: <https://doi.org/10.1016/j.jadohealth.2013.08.010>
- Conger, S. A., Toth, L. P., Cretsinger, C., Raustorp, A., Mitas, J., Inoue, J., & Basset, D. R.** (2022). Time trends in physical activity using wearable devices: a systematic review and meta-analysis of studies from 1995 to 2017. *Medicine and Science in Sports and Exercise*, 54(2), 288–298. DOI: <https://doi.org/10.1249/mss.0000000000002794>
- Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P.** (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, 35(8), 1381–1395. DOI: <https://doi.org/10.1249/01.mss.0000078924.61453.fb>
- Guedes, D. P., Lopes, C. C., & Guedes, J. E.** (2005). Reprodutibilidade e validade do Questionário Internacional de Atividade Física em adolescentes. *Revista Brasileira de Medicina do Esporte*, 11, 151–158. DOI: <https://doi.org/10.1590/S1517-86922005000200011>
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C.** (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, 6(10), e1077–e1086. DOI: [https://doi.org/10.1016/S2214-109X\(18\)30357-7](https://doi.org/10.1016/S2214-109X(18)30357-7)
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C.** (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *The Lancet Child & Adolescent Health*, 4(1), 23–35. DOI: [https://doi.org/10.1016/s2352-4642\(19\)30323-2](https://doi.org/10.1016/s2352-4642(19)30323-2)
- Henriques-Neto, D., Peralta, M., Garradas, S., Pelegrini, A., Pinto, A. A., Pedro António Sánchez-Miguel, P. A., & Marques, A.** (2020). Active commuting and physical fitness: A systematic review. *International Journal of Environmental Research and Public Health*, 17(8), 2721. DOI: <https://doi.org/10.3390/ijerph17082721>
- Hsu, M. Y., Li, Y. C., Hong, F. Y., & Liou, Y. M.** (2021). Is Brisk Walking an Effective Physical Activity for promoting Taiwanese Adolescents' Mental Health? *Journal of Pediatric Nursing*, 60, e60–e67. DOI: <https://doi.org/10.1016/j.pedn.2021.03.012>
- Loureiro, N., Loureiro, V., Grao-Cruces, A., Martins, J., & Matos, M. G.** (2022). Correlates of active commuting to school among Portuguese adolescents: an ecological model approach. *International Journal of Environmental Research and Public Health*, 19(5), 2733. DOI: <https://doi.org/10.3390/ijerph19052733>
- Luiz, R. R., & Magnanini, M. M. F.** (2000). The logic of sample size determination in epidemiological research. *Cadernos de Saúde Pública*, 8, 8–28.
- Martinez-Gomez, D., Mielke, G. I., Menezes, A. M., Gonçalves, H., Barros, F. C., & Hallal, P. C.** (2014). Active commuting throughout adolescence and central fatness before adulthood: prospective birth cohort study. *PLoS One*, 14; 4(5), e96634. DOI: <https://doi.org/10.1371/journal.pone.0096634>
- Oja, P., Kelly, P., Murtagh, E. M., Murphy, M. H., Foster, C., & Titze, S.** (2018). Effects of frequency, intensity, duration and volume of walking interventions on CVD risk factors: a systematic review and meta-regression analysis of randomised controlled trials among inactive healthy adults. *British Journal of Sports Medicine*, 52(12), 769–775. DOI: <https://doi.org/10.1136/bjsports-2017-098558>
- Pavelka, J., Sigmundová, D., Hamřík, Z., Kalman, M., Sigmund, E., & Mathisen, F.** (2017). Trends in Active Commuting to School among Czech Schoolchildren from 2006 to 2014. *Central European Journal of Public Health*, 25, S21–S25. DOI: <https://doi.org/10.21101/cejph.a5095>

- Pinto, A. A., Claumann, G. S., Angelo, H. C., Menezes, E. C., Dias, D. T., & Pelegrini, A.** (2018). Active commuting to school and associated factors among adolescents: a systematic review. *Journal of Physical Education*, 28, e2859. DOI: <https://doi.org/10.4025/jphyseduc.v28i1.2859>
- Pinto, A. A., Fernandes, R. A., Silva, K. S., Silva, D. A. S., Beltrame, T. S., Cardoso, F. L., & Pelegrini, A.** (2022). Physical Activity Levels in Brazilian Adolescents: A Secular Trend Study (2007–2017/18). *International Journal of Environmental Research and Public Health*, 19(24), 16901. DOI: <https://doi.org/10.3390/ijerph192416901>
- Pinto, A. A., Françosi, F. L., Nahas, M. V., Puga Barbosa, R. M., Silva, D. A. S., Costa, A. M., Bim, M. A., Scarabelot, K. S., Claumann, G. S., & Pelegrini, A.** (2021). Prevalência e fatores sociodemográficos associados ao deslocamento passivo para a escola: comparação entre adolescentes de distintas regiões do Brasil. *Motricidade*, 17(1), 15–22. DOI: <https://doi.org/10.6063/motricidade.19453>
- Pinto, A. A., Marques, A. C. M., & Pelegrini, A.** (2023). Secular trends in physical activity in adolescents: A systematic review. *Journal of Taibah University Medical Sciences*, 17(1), 1–9. DOI: <https://doi.org/10.1016/j.jtumed.2022.09.004>
- Pinto, A. A., Silva, D. A., Silva, K. S., Felden, E. P. G., & Pelegrini, A.** (2020). Inatividade física no deslocamento para a escola e fatores associados em adolescentes de uma cidade do Sul do Brasil. *Revista Brasileira de Educação Física e Esporte*, 34(1), 123–132. DOI: <https://doi.org/10.11606/1807-5509202000010123>
- Ramires, V. V., Dumith, S. C., Wehrmeister, F. C., Hallal, P. C., Menezes, A. M. B., & Gonçalves, H.** (2016). Physical activity throughout adolescence and body composition at 18 years: 1993 Pelotas (Brazil) birth cohort study. *International Journal of Behavioral Nutrition and Physical Activity*, 13(105), 1–13. DOI: <https://doi.org/10.1186/s12966-016-0430-6>
- Rech, C., Reis, R., Hino, A., De Sá, G., Stopa, S., & Malta, D.** (2015). Tendências temporais de atividade física e comportamento sedentário nas capitais da Região Sul do Brasil: 2006–2013. *Revista Brasileira de Atividade Física e Saúde*, 20(1), 47–56. DOI: <https://doi.org/10.12820/rbafs.v.20n1p47>
- Rehling, J., Bunge, C., Waldhauer, J., & Conrad, A.** (2021). Socioeconomic differences in walking time of children and adolescents to public green spaces in urban areas—results of the German environmental survey (2014–2017). *International Journal of Environmental Research and Public Health*, 18(5), 2326. DOI: <https://doi.org/10.3390/ijerph18052326>
- Salmon, J., Timperio, A., Cleland, V., & Venn, A.** (2005). Trends in children’s physical activity and weight status in high and low socio-economic status areas of Melbourne, Victoria, 1985–2001. *Australian and New Zealand Journal of Public Health*, 29(4), 337–342. DOI: <https://doi.org/10.1111/j.1467-842x.2005.tb00204.x>
- Uddin, R., Lee, E. Y., Khan, S. R., Tremblay, M. S., & Khan, A.** (2020). Clustering of lifestyle risk factors for non-communicable diseases in 304,779 adolescents from 89 countries: A global perspective. *Preventive Medicine*, 131, 105955. DOI: <https://doi.org/10.1016/j.ypmed.2019.105955>
- Uddin, R., Mandic, S., & Khan, A.** (2019) Active commuting to and from school among 106,605 adolescents in 27 Asia-Pacific countries. *Journal of Transport & Health*, 15, 500637. DOI: <https://doi.org/10.1016/j.jth.2019.100637>
- Ussery, E. N., Carlson, S. A., Whitfield, G. P., Watson, K. B., Berrigan, D., & Fulton, J. E.** (2018). Transportation and leisure walking among US adults: trends in reported prevalence and volume, National Health Interview Survey 2005–2015. *American Journal of Preventive Medicine*, 55(4), 533–40. DOI: <https://doi.org/10.1016/j.amepre.2018.05.027>
- Villa-González, E., Huertas-Delgado, F. J., Chillón, P., Ramírez-Vélez, R., & Barranco-Ruiz, Y.** (2019). Associations between active commuting to school, sleep duration, and breakfast consumption in Ecuadorian young people. *BMC Public Health*, 19(1), 85. DOI: <https://doi.org/10.1186/s12889-019-6434-9>
- World Health Organization.** (2018). *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World*. Geneva, Switzerland: WHO.

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