School sustainability norms and adolescents' active transportation as a form of physical activity: a mediation analysis

Normas de sostenibilidad escolar y el transporte activo de los adolescentes como forma de actividad física: un análisis de mediación

Authors

Laima Gasiuniene [1]
Brigita Mieziene [1]
Kristina Motiejunaite [1]

[1] Lithuanian Sports University (Lithuania)

Corresponding author:
Laima Gasiuniene
laima.gasiuniene@yahoo.com

Received: 01-03-26
Accepted: 20-04-26

How to cite in APA

Gasiuniene, L., Mieziene, B., & Motiejunaite, K. (2026). School sustainability norms and adolescents' active transportation as a form of physical activity: a mediation analysis. *Retos, 79,* 764-776. https://doi.org/10.47197/retos.v79.118920

Abstract

Introduction: Active transportation is an important component of sustainable development, contributing to climate change mitigation and promoting physical activity and health. Schools play a key role in fostering sustainable behaviors by creating environments that support active transportation.
Objective: This study aimed to examine the direct and indirect relationships between school sustainability norms and students' attitudes, subjective norms, perceived behavioral control, intention, and active transportation behavior.
Methodology: A cross-sectional study was conducted among 1005 students aged 15–19 years. Psychosocial variables were assessed using the Theory of Planned Behavior framework, and active transportation was measured using the Global Physical Activity Questionnaire. Linear regression and mediation analyses were performed.
Results: The results showed that school sustainability norms were significantly associated with subjective norms and perceived behavioral control. Intention to use active transportation was predicted by subjective norms and perceived behavioral control and was significantly associated with active transportation behavior. Mediation analysis confirmed that school sustainability norms indirectly influenced intention through subjective norms and perceived behavioral control.
Discussion: These findings suggest that school sustainability norms play an important role in promoting active transportation indirectly by strengthening psychosocial determinants. Conclusions: Schools implementing sustainable development principles and providing supportive infrastructure may encourage active transportation among students.

Keywords

Active transportation; adolescents; physical activity; school environment; theory of planned behavior.

Resumen

Introducción: El transporte activo fue identificado como un componente importante del desarrollo sostenible, ya que contribuye a la mitigación del cambio climático y promueve la actividad física y la salud. Las escuelas fueron consideradas entornos clave para fomentar comportamientos sostenibles al facilitar el transporte activo.
Objetivo: El objetivo de este estudio fue examinar las relaciones directas e indirectas entre las normas de sostenibilidad escolar y las actitudes de los estudiantes, las normas subjetivas, el control conductual percibido, la intención y el comportamiento de transporte activo.
Metodología: Se realizó un estudio transversal con 1005 estudiantes de 15 a 19 años. Las variables psicosociales se evaluaron utilizando la Teoría del Comportamiento Planificado, y el transporte activo se midió mediante el Global Physical Activity Questionnaire. Se realizaron análisis de regresión lineal y mediación.
Resultados: Los resultados mostraron que las normas de sostenibilidad escolar se asociaron con las normas subjetivas y el control conductual percibido. La intención de utilizar transporte activo fue predicha por estas variables y se asoció con el comportamiento de transporte activo. El análisis de mediación confirmó que las normas de sostenibilidad escolar influyeron indirectamente en la intención.
Discusión: Estos hallazgos indicaron que las normas de sostenibilidad escolar desempeñaron un papel importante en la promoción del transporte activo al fortalecer los determinantes psicosociales.
Conclusiones: Las escuelas que implementan principios de desarrollo sostenible y proporcionan infraestructura de apoyo pueden fomentar el transporte activo entre los estudiantes.

Palabras clave

Actividad física; adolescentes; entorno escolar; teoría del comportamiento planificado; transporte activo.

Introduction

Active transportation (AT) refers to all forms of human travel by non-motorized means and is based on physical activity. The most common forms of AT are walking, cycling, and riding a scooter (Kim & Hall, 2022; Larouche et al., 2018). AT is an interdisciplinary concept frequently discussed in the scientific literature on sustainable development, particularly in the areas of education, transportation, health, urban planning, and environmental sustainability, and it is recognized as a means of contributing to both human health and environmental well-being. Research examining the relationship between sustainable development and AT has shown that societies engaging in AT benefit not only from improved health due to increased physical activity but also from additional advantages such as reduced fossil fuel consumption, cleaner air, reduced congestion, and safer roads (Baena-Morales & González-Víllora, 2022; Dai & Menhas, 2020; Mizdrak et al., 2019; Salvo et al., 2021). AT has attracted increasing attention from researchers not only because of its dual benefits for human and environmental well-being, but also because it is considered one of the most promising ways to achieve a physically active society (Ding et al., 2024; Salvo et al., 2021). The most used forms of AT, such as walking, cycling, and riding a scooter, are widely accessible and convenient for everyone, thereby helping to integrate physical activity into people's daily lives and even effectively replacing short car trips (Allen & Nolmark, 2022; Kim & Hall, 2022). For these reasons, AT is frequently discussed in the context of sustainable development as an important tool that can contribute to achieving the Sustainable Development Goals (Ding et al., 2024; Salvo et al., 2021). The importance of AT in achieving the Sustainable Development Goals has also been recognized by the World Health Organization, which in 2018 released the Physical Activity Action Plan More Active People for a Healthier World 2018–2030, highlighting that AT can contribute to creating a more sustainable, equitable, and healthier world (World Health Organization, 2019). One of the key areas of interest for researchers in advancing AT studies is identifying the factors influencing AT use. Given that young people have been assigned the role of change agents in achieving the Sustainable Development Goals (Atikoh et al., 2024) and that those aged 15–24 account for almost 16% of the world's population (United Nations, 2019), it is important to study young people whose awareness is still developing to implement timely interventions. Schools play a vital role in promoting sustainable behaviors. Research shows that students are more likely to choose AT in schools that emphasize sustainable development, address environmental protection, highlight the benefits of AT, promote health-enhancing behaviors, and provide facilities for bicycle and scooter storage (Buttazzoni et al., 2024; Schönbach et al., 2020). However, research on this topic remains limited among older adolescents.

The latest physical activity guidelines recommend that adolescents engage in at least 60 minutes of moderate-to-vigorous physical activity daily. However, many young people do not meet these recommendations (Guthold et al., 2020; Rakić et al., 2024). As noted by Bull et al. (2020) and Guthold et al. (2020), only 19% of school-aged children (11–17 years) achieve the minimum recommended level of physical activity. Recent studies have shown that the most physically active adolescents are those who take advantage of the greatest opportunities for physical activity throughout the day, with AT contributing substantially to their daily activity levels (Derigny et al., 2022; Sáez Padilla et al., 2022). A systematic review revealed that AT to and from school can provide nearly 48% of the recommended 60 minutes of daily physical activity for children and adolescents (Concha et al., 2024; Campos-Garzón et al., 2023). Research has also shown that students who use AT (e.g., walking or cycling) to get to school are more physically active, healthier, and more productive than those who rely on motorized transport (Concha et al., 2024). At the societal level, students using AT contribute to reducing greenhouse gas emissions (Larouche et al., 2014). AT is recognized as a low-cost form of physical activity that can be integrated into daily routines, as most children and adolescents travel to and from school each day (Larouche et al., 2014). Nevertheless, in recent decades, the prevalence of active school transport has declined in many countries. For example, in the United States, approximately 41% of children walked or cycled to school in 1969, but by 2001, this number had declined to 13% (McDonald, 2007). In Germany, the proportion decreased from 84.4% in 2003 to 78.3% in 2017 (Wex et al., 2023). Rakić et al. (2024), in a comparative analysis of students from 49 countries considering social, economic, and geographic factors, found that the prevalence of AT use varied widely, ranging from 20% to 80%. The highest levels were observed in Japan, Nepal, and Zimbabwe, where more than 80% of students used AT, while the lowest were in the United States, where fewer than 30% did so. Higher rates of AT were associated with greater population density, fewer cars per capita, and higher fuel prices. Guthold et al. (2020) also noted that AT use is most

prevalent in Europe and Asia and least common in North America. Furthermore, data show that over a period of less than 40 years (1969–2009), the proportion of students walking or cycling to school in the U.S. declined from 42% to 13% (Safe Routes to School National Partnership, n.d.).

In exploring ways to promote AT among young people, researchers have focused on schools that operate under the principles of education for sustainable development. In such schools, considerable attention is given to fostering health-promoting and environmentally sustainable behaviors, and various programs are implemented to encourage such behaviors, including AT. According to researchers (Cieśla & Macioszek, 2022), school policies grounded in sustainable development principles are key to fostering health-promoting behaviors, including AT behavior. Examples of such school-based initiatives and interventions can be seen in the Sustainable School Travel Plan initiatives implemented in urban schools in New Zealand (Ikeda et al., 2018), Canada (Mammen et al., 2014), and the USA (McDonald et al., 2014). These sustainability-driven initiatives to increase AT have included educational and promotional campaigns, provision of cycling facilities, student bicycle training, parking restrictions, traffic calming measures, and improvements to roads and pedestrian pathways (Hinckson & Faulkner, 2018). Other well-known school initiatives designed to promote AT include Walking School Buses (Scharoun Benson et al., 2020), Safe Routes to School (Rodriguez et al., 2019), Sustainable Innovation for Active School Transport (Lindqvist & Rutberg, 2018), and Learn to Ride a Bike (Derigny et al., 2024b).

Researchers agree that school engagement in sustainable development policies (i.e., schools that emphasize environmentally friendly behavior, sustainability, encourage pro-environmental practices, and provide conditions for such practices) is associated with greater AT use (Baena-Morales & González-Víllora, 2022; Cieśla & Macioszek, 2022; Derigny et al., 2024a; Larouche et al., 2018).

The Present Study. The Theory of Planned Behavior (Ajzen, 2006) posits that behavioral engagement is directly associated with behavioral intention and perceived behavioral control, under the condition that the latter reflects realistic capacity. Intention, in turn, is shaped by perceived behavioral control, attitude toward the behavior (or its outcomes), and subjective norm, which encompasses perceived social expectations regarding the behavior.

In the present study, we specify this framework by proposing that intention to engage in AT - as a deliberate behavioral choice - may be associated with both general pro-sustainability attitudes and specific attitudes toward AT. For high school students, intention may further be related to subjective norms about sustainability in general and social pressures specific to AT engagement. Additionally, we extend the model stating that organizational factors (e.g., school-level norms on sustainability and AT) may shape individual-level determinants, including attitude, subjective norm, and perceived behavioral control.

Study Aims and Hypotheses. This study aims to examine the direct and indirect relationships between a school's sustainability norms and attitude, subjective norms, perceived behavioral control, and intention to engage in active transportation, as well as weekly time spent in active transportation among high school students.

We hypothesize that:

1. A school's sustainability norms will be positively associated with more favorable attitudes toward sustainability and active transportation, stronger subjective norms, and higher perceived behavioral control.
2. Attitude, subjective norm, and perceived behavioral control will mediate the relationship between the school's sustainability norms and active transportation intention.
3. Attitude, subjective norm, and perceived behavioral control, along with intention, will further mediate the relationship between the school's sustainability norms and time spent in active transportation.

Method

Participants

The study included 1005 high school students, aged 14 to 19 years, with a mean age of 16.18 (1.16) years. Among them, 53.9% were female.

Study design and procedure

This cross-sectional study was conducted at schools across five of the ten counties in Lithuania, including both urban and regional schools. A total of 16 schools were randomly selected for participation. School administrations were contacted to obtain consent for the study; if a school declined, a similar school within the same county was selected as a substitute. From each participating school, one class per grade level (grades 9 through 12) was chosen, and all students in these selected classes completed an online questionnaire, which took approximately 30 minutes to fill out, provided they had obtained parental consent. Data collection took place between September and December 2024. Ethical approval for the study was granted by the Lithuanian Sports University's Committee of Bioethics (permission no. 27720). The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Instruments

Active transportation was assessed using the "Travel to and from places" subscale of the Global Physical Activity Questionnaire (GPAQ), developed by the World Health Organization (World Health Organization, 2009). Two items were employed to measure active transportation: frequency (days per week) and duration (time per travel). The first item asked, "In a typical week, on how many days do you walk or bicycle continuously for at least 10 minutes to get to and from places?" The second item inquired about the amount of time spent walking or bicycling for travel on a typical day. From these responses, the total weekly time spent engaging in active transportation was calculated in minutes.

The constructs related to the Theory of Planned Behavior were developed following established guidelines. The questionnaire included 31 items, with responses recorded on a 7-point Likert scale ranging from 1 (do not agree) to 7 (totally agree). Scores for items within each construct were summed and then averaged based on the number of items, with higher scores indicating stronger expression of the respective construct.

Exploration factor analysis made on data of half of the sample (500 participants) revealed that structure of six factors had the best fit (chi-square = 1442, p <.001; CFI = .965; TLI = .944; RMSEA = .062 [.059 - .066]; SRMR = .014). The following factors were derived:

Attitudes toward sustainability (7 items, e.g. "Acting in an environmentally friendly way will contribute to protecting the environment"). Cronbach alpha .928.

Attitudes toward active transportation (5 items, e.g. "Active transportation helps protect the environment"). Cronbach alpha .953.

Subjective norm toward sustainability (4 items, e.g. "My loved ones have a positive attitude toward environmentally friendly behavior in the context of sustainable development."). Cronbach alpha .935.

Subjective norm toward active transportation (4 items, e.g. "My loved ones would support me if I used active transportation"). Cronbach alpha .899.

Perceived behavioral control to perform active transportation (4 items, e.g. "Whether or not to use active transportation depends on me."). Cronbach alpha .884.

Intention to perform active transportation (7 items, e.g. "I plan to use active transportation for the sake of environmental conservation."). Cronbach alpha .961.

On the rest of the sample, Confirmatory factor analysis was performed and confirmed the structure of the Theory of Planned Behavior questionnaire (chi-square = 2230, p <.001; CFI = .944; TLI = .938; RMSEA = .066 [.063 - .068]; SRMR = .036).

School sustainability norms were assessed using three items that reflected different aspects of sustainability within the school context: sustainability-related education ("Information on sustainability issues

is provided at school"), promotion of sustainability behaviors ("Sustainable behaviors are encouraged at school"), and sustainability-friendly infrastructure ("There are safe bicycle and scooter storage facilities at school"). Responses were recorded on a Likert scale ranging from 1 (totally disagree) to 5 (totally agree). Exploratory factor analysis identified a single underlying factor, which accounted for 71% of the variance. The factors for the items ranged from .691 to .924, indicating strong associations with the factor. The scale demonstrated good internal consistency, with a Cronbach's alpha of .872.

Statistical analysis

SPSS 28.0 (SPSS Inc., Chicago, IL, USA) and Mplus 8.4 software were used to perform data analysis in this study. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted to determine the underlying factor structure of the questionnaire. For the hypothetical structural equation mediation model, several fit indices were utilized to evaluate model adequacy: 1) The root mean square error of approximation (RMSEA) with its 90% confidence interval (CI), which is a population-based measure less affected by sample size. RMSEA values of .01, .05, and .08 indicate excellent, good, and mediocre fit, respectively; 2) The Standardized Root Mean Squared Residual (SRMR), which directly measures how well the proposed model reproduces the observed data. Values below .05 indicate very good fit, while values under .08 indicate a good fit; 3) The comparative fit index (CFI) and 4) the Tucker–Lewis index (TLI), both of which compare the hypothesized model's fit to a baseline model representing the worst fit. Values greater than .90 suggest good fit, and values above .95 indicate excellent fit (Kline, 2023). Parameters were estimated using maximum likelihood (ML) estimation based on the observed data and the assumed probability distribution. Descriptive statistics were calculated to determine the means and standard deviations (SD) for continuous scale variables, while frequencies and percentages were used to describe nominal categorical variables. To compare group differences, Student's t-tests were applied for mean values, and chi-square tests were used to examine differences in categorical frequency distributions. Pearson correlation coefficients were calculated to explore the relationships among the main study variables. Linear regression analyses were performed to identify significant predictors of both intention to use active transportation and actual active transportation behavior. Additionally, mediation analysis was conducted using the PROCESS macro version 3.5. (Hayes, 2018) SPSS macro (Model 4) to investigate indirect effects within the proposed models. Statistical significance was set at a p-value of less than .05, indicating that results meeting this threshold were considered statistically significant.

Results

Table 1 presents descriptive statistics on control variables in this study and their comparison between genders.

Table 1. Comparison of students' socio-economic status and vehicle ownership by gender

	Variable	All students N (%)	Girls N (%)	Boys N (%)	χ^2 (df)	P
Financial situation	Worse than national average	59 (5.9)	36 (6.6)	23 (5.0)	8.54 (2)	.014
	Better than national average	433 (43.1)	389 (21.1)	222 (47.9)		
	Same as national average	513 (51)	295 (54.4)	218 (47.1)		
Car	Do not own	706 (70.2)	385 (71)	321 (69.3)	0.346 (1)	.556
	Own	299 (29.8)	157 (29)	142 (30.7)		
Bicycle	Do not own	387 (38.5)	222 (41)	165 (35.6)	0.987 (1)	.084
	Own	618 (61.5)	320 (59)	298 (64.4)		

Note. Data on the distribution of students by financial status and vehicle ownership are presented.

As shown in Table 1, most adolescents evaluated their families' financial status as average. However, the assessment of financial status differed by gender. Boys were more likely to report that their family's financial situation was better than the national average, whereas girls more frequently chose the option "the same as the national average". In contrast, car and bicycle ownership did not differ significantly between boys and girls, suggesting that these material resources are similarly accessible to both genders.

Descriptive statistics and analyses of gender differences in the Theory of Planned Behavior variables (attitudes, subjective norms, perceived control, intention) and physical activity indicators (duration of active transportation use) were conducted to assess the relative magnitude of these variables. The results are presented in Table 2.

Table 2. Comparison of the Theory of Planned Behavior variables and active transportation measures by gender

Variable	All students; Mean (SD)	Groups	Mean (SD)	t (p)	Cohen 's d
Attitude toward AT	4.66 (1.79)	Girls	4.91 (1.80)	4.77 (.001)	1.77
		Boys	4.37 (1.73)		
Attitude toward SDev	4.54 (1.60)	Girls	4.82 (1.56)	4.91 (.001)	1.58
		Boys	4.21 (1.59)		
Subjective norm for AT	4.33 (1.63)	Girls	4.56 (1.66)	4.91 (.001)	1.61
		Boys	4.06 (1.56)		
Subjective norm for SDev	4.54 (1.71)	Girls	4.81 (1.70)	5.57 (.001)	1.68
		Boys	4.22 (1.66)		
Perceived behavioral control	4.32 (1.67)	Girls	4.41 (1.68)	1.94 (.53)	1.67
		Boys	4.21 (1.65)		
Intention to use AT	4.06 (1.75)	Girls	4.13 (1.80)	1.35 (.18)	1.75
		Boys	3.98 (1.70)		
Use of AT (minutes per week)	223.86 (280.40)	Girls	199.01 (259.57)	-3.05 (.002)	279.25
		Boys	252.89 (300.66)		

Note. AT – active transportation; SDev – sustainable development; SD – standard deviation.

Table 2 shows that girls have more positive attitudes toward active transportation and sustainable development than boys. Meanwhile, boys spend a statistically significantly greater amount of time per week using active transportation than girls. No significant gender differences were found in perceived behavioral control or intention to use active transportation. To examine the correlations between school sustainability norms, Theory of Planned Behavior variables (attitudes, subjective norms, perceived behavioral control, and intention), and active transportation use, Pearson correlation coefficients were calculated. The results are presented in Table 3.

Table 3. Pearson Correlation Coefficients

Variables	1	2	3	4	5	6	7
1. School sustainability norms	1						
2. Attitudes toward AT	.58**	1					
3. Attitudes toward SDev	.57**	.77**	1				
4. Subjective norm for AT	.58**	.65**	.71**	1			
5. Subjective norm for SDev	.60**	.70**	.75**	.78**	1		
6. Perceived behavioral control	.53**	.62**	.63**	.68**	.69**	1	
7. Intention to use AT	.43**	.54**	.56**	.64**	.59**	.73**	1
8. AT use	-.03	-.08	-.05	.01	.34	.28	.73*

Note. AT - active transportation; SDev - sustainable development; **p < .01, *p < .05.

As shown in Table 3, school sustainability norms were positively associated with both attitudes toward AT and sustainable development, subjective norms, perceived behavioral control, and intention to use AT. However, school sustainability norms were not related to actual AT use. Overall, the results indicate that while school-level interventions can encourage more favorable attitudes and stronger intentions, they do not necessarily translate into changes in actual behavior.

To identify which sociodemographic, psychological (Theory of Planned Behavior elements), and school-related factors predict students' AT use, a hierarchical regression analysis was conducted. The results are presented in Table 4.

Table 4. Results of regression models predicting intention to use active transportation

Variable	Standardized beta		
	Model 1	Model 2	Model 3
Gender	-.041	.041*	.044*
Age	.116***	.043*	.043*
Financial situation	.072*	.036	.038
Bicycle ownership	.018	-.026	-.026
Car ownership	-.013	-.018	-.018

Attitudes toward AT		.038	.047
Attitudes toward SDev		.031	.035
Subjective norm for AT		.236***	.243***
Subjective norm for SDev		.011	.020
Perceived behavioral control		.516***	.521***
School sustainability norms			-.046
ΔR2	.020***	.556***	.001

Note. Standardized beta coefficients (β) are presented. *p < .05, **p < .01, ***p < .001. AT - active transportation; SD - sustainable development.

In the first model, which included sociodemographic variables, older age and better financial situation emerged as significant predictors of intention, explaining 20% of the variance. When the Theory of Planned Behavior variables were added in the second model, the explanatory power increased substantially, accounting for 55.6% of the variance in intention. In this model, alongside the control variables age and gender, subjective norm for active transportation and perceived behavioral control were significant predictors. Adding the school sustainability factor in the third model did not increase explanatory power. In the final model, subjective norm for active transportation, perceived behavioral control, age, and gender remained significant.

In summary, these findings suggest that perceived behavioral control is the strongest predictor of intention to use active transportation, followed by subjective norm. Additionally, boys and older adolescents showed stronger intentions to use active transportation. School sustainability norms did not directly predict intention to use active transportation.

Table 5. Results of regression models predicting the use of active transportation

Variable	Standartized beta		
	Model 1	Model 2	Model 3
Gender	.092**	.080*	.081*
Age	-.008	.010	-.010
Financial situation	-.036	-.042	-.041
Bicycle ownership	.052	.063*	.063*
Car ownership	-.039	-.037	-.037
Attitudes toward AT		-.131	-.126
Attitudes toward SDev		-.048	-.046
Subjective norm for AT		.082	.086
Subjective norm for SDev		-.011	-.007
Perceived behavioral control		.021	.024
Intention to use AT		.119*	.118*
School sustainability norms			-.022
ΔR^2	.015*	.021**	.001

Note. Standardized beta coefficients (β) are presented. *p < .05, **p < .01. AT - active transportation; SDev - sustainable development.

Table 5 presents the results of the hierarchical regression analysis predicting students' use of AT. The first model, which included sociodemographic variables, showed that gender was a significant predictor, with boys more likely to use AT, while other sociodemographic variables such as age, financial situation, and vehicle ownership were not related. The first model explains 15% of AT variance. In the second model, which additionally included factors of the Theory of Planned Behavior, besides control variables – male gender and bicycle ownership, which predicted greater use of AT - also intention to use AT emerged as a significant predictor. The second model additionally added 21% to the explanation of AT variance. The third model, which incorporated the school sustainability norms, did not explain additional variance. In summary, stronger intention to use AT, being male, and bicycle ownership predicted greater use of AT. School sustainability factors were not directly related to AT.

A mediation analysis was performed to examine the indirect effects of the school sustainability norms on students' intention to use AT. Results are presented in Table 6.

Table 6. Mediation effects in predicting and intention to use and actual active transportation use

Independent–dependent variable indirect link	Mediator or sequence of mediators (independent variable affects dependent variable through:)	Indirect effect		CSIE (Completely standardized indirect effect)	
		B	95% CI	β	95% CI
School Sustainability norms – Intention to use AT					

Subjective norm AT	0.34	[0.29-0.40]	0.34	[0.29-0.39]
Perceived behavioral control	0.37	[0.32-0.43]	0.37	[0.32-0.42]
School Sustainability norms– AT use				
Subjective norm AT → Intention to use AT	7.30	[-0.65-15.47]	0.05	[0.00-0.09]
Perceived behavioral control → Intention to use AT	6.72	[0.28-13.65]	0.04	[0.00-0.08]

Note. AT - active transportation; CSIE - Completely Standardized Indirect Effect. If the confidence interval (BootLLCI–BootULCI) does not include zero (0), the indirect effect is statistically significant.

As shown in Table 6, school sustainability norms are indirectly related to the intention to use AT by increasing both the subjective norm and perceived behavioral control related to AT. School sustainability norms also play a significant role in double mediation predicting AT behavior: by enhancing the subjective norm to use AT, which strengthens intention, they ultimately promote AT behavior. Similarly, school sustainability norms are related to AT indirectly through increased perceived behavioral control, followed by increased intention. These results indicate that school sustainability norms are positively associated with AT use through their effects on subjective norms and perceived behavioral control.

Discussion

This study aimed to examine the direct and indirect impact that organizational factors, such as schools' sustainability norms, can have on active transportation through psychosocial factors, including attitudes, subjective norms toward active transportation and sustainability, perceived behavioral control, and intention.

The results of this study show that school sustainability norms—such as education, creating a supportive environment for active transportation, and promoting active transportation—operate through subjective norms and perceived behavioral control to shape intentions to use active transportation. No direct relationship was found between school sustainability norms and active transportation. However, these indirect associations align with the Theory of Planned Behavior, which states that behavioral intentions are determined by attitudes, subjective norms, and perceived behavioral control, with perceived behavioral control and intentions together predicting behavior (Ajzen, 2006). At the same time, school sustainability norms affect personal norms and perceptions of the ability to perform the behavior, which is consistent with the socio-ecological approach (Sallis, 2015), emphasizing that organizational-level factors interact with factors at interpersonal and individual levels.

The data obtained show that subjective norms toward AT and perceived behavioral control are the strongest mediators between the school environment and students' intentions and AT behavior. Scharoun Benson et al. (2020) and Pang et al. (2017) highlight the school environment as a source of social norms, noting that if walking or cycling is common in the school context, it becomes a norm that other students adopt. Schools can foster such a context through education and infrastructure elements, for example, bicycle racks and storage facilities. In this way, the message is conveyed that AT is not only encouraged but also genuinely supported. These measures make AT socially acceptable and desirable (Pang et al., 2017; Scharoun Benson et al., 2020). However, some other studies found direct relationships between attitudes, subjective norms, and AT. One of the studies showed that a higher perception of social norm (injunctive norm) and a modelling (descriptive norm) for AT to school was related to higher walking and cycling to school among Flemish older adolescents (Verhoeven et al., 2016). However, social norms can work in the opposite direction as well. Qualitative study revealed that if adolescent's friends regularly use public transportation or hold a driver's or moped license, they are likely to adopt these motorized modes of transportation as well (Simons et al., 2013). These results are supported by quantitative study which indicates that social support from parents and friends in practicing AT together is related to greater AT to school (Camargo et al., 2020; McDonald et al., 2010).

Our study did not reveal the direct relationships between attitudes, subjective norms, and AT, probably because of the impact of the third factors, like built environment, which might impact both attitudes toward AT and actual behavior. There is also study that explains the complex and indirect relationship between attitudes and AT. Authors state that positive attitudes toward AT work for behavior only in case the built environment is friendly for AT. Moreover, the opposite relationship is also possible – when

built environment defines AT as the most convenient option for commuting, attitudes toward AT can be shifted from negative to positive along (Kroesen & De Vos, 2020). Similarly, self-efficacy or perceived behavioral control works effectively in case there is favorable infrastructure for the performing behavior (Ruiz-Alarcón et al., 2025; Wang et al., 2017).

Zooming into the qualitative studies 'results, it could be noticed that even those positive attitudes toward AT adolescents have, those attitudes still do not define their commuting behavior (Camargo et al., 2024; Simons et al., 2013). Instead, young people make their commuting decisions based on travel time, financial costs, vehicle ownership, and leaving ecology and health motives as not important at all (Ruiz-Alarcón et al., 2025; Simons et al., 2017).

However, the influence of psychosocial factors is most evident when combined with structural measures such as infrastructure, policy, and education (Savolainen et al., 2024). The results of this study complement recent systematic literature reviews, which show that the physical environment of the school, when combined with education, becomes one of the strongest predictors of student behavior change related to AT (Ding et al., 2024; Roaf et al., 2024). Systematic reviews conducted specifically in the school context (Larouche et al., 2018; McDonald et al., 2014; Schönbach et al., 2020) have demonstrated that the most successful programs are characterized not only by changes in the physical environment, but also by the active role of the school (i.e., support from administration and teachers, integration of programs into daily activities, and community involvement), which proves to be a decisive factor. Larouche et al. (2018) found that programs in which schools assume an organizational leadership role are significantly more effective than those limited to providing information or implementing one-off campaigns. In other words, a neutral or passive school role constrains the impact of interventions, whereas an active role amplifies the effect both through the formation of social norms and by enhancing students' confidence in their own abilities (perceived control).

Additionally, it is important to consider socio-demographic factors, which also have a significant effect on the choice of AT. The data from this study, consistent with the findings of other authors (González et al., 2020; Wex et al., 2023), show that gender plays a role: girls more often report favorable attitudes toward sustainability, but in practice, boys are more likely to use AT, particularly bicycles. Financial status is also an important factor - recent studies indicate that families with greater financial resources are more likely to own cars, which reduces the need for AT, while less affluent students are more likely to travel on foot or by public transport (Power & Fitzpatrick, 2023). Car ownership is identified in research as a barriers to AT, as it increases dependence on motorized mobility (Hinckson, 2016; Larouche et al., 2014; McDonald et al., 2010). In contrast, bicycle ownership is a significant facilitator of AT - students who own a bicycle are twice as likely to ride it to school (Schönbach et al., 2020).

Considering the results, it can be stated that the school environment plays a dual role: it shapes the physical and organizational setting that creates opportunities for AT, and it fosters social norms and trust that are essential for long-term behavior change. Without an active role of the school, interventions targeting students are often fragmented and less effective. As an important organizational structure, the school needs to create an environment that integrates infrastructural solutions with AT, promoting education and supportive programs.

Conclusions

The results of this study confirm that school sustainability norms play an important role in promoting students' use of AT. Schools that systematically implement the principles of sustainable development and introduce both educational and infrastructural initiatives create a supportive environment for health- and environmentally friendly behaviors. This, in turn, is directly associated with more favorable student attitudes, subjective norms, and perceived behavioral control related to AT. The findings further indicate that although school sustainability norms are not directly linked to actual AT use, their effect emerges through a chain of mediators: favorable attitudes, subjective norms, and perceived behavioral control increase the intention to use AT, which in turn promotes actual AT use. These results support the assumptions of the Theory of Planned Behavior, which posits that behavior largely depends on intentions and individual psychological factors, both of which can be shaped by organizational and environmental measures. In summary, the creation of school sustainability norms and the implementation

of sustainable development policies represent effective strategies for fostering favorable attitudes and intentions toward AT, which in turn may encourage students' actual AT use.

References

Ajzen, I. (2006). *Behavioral interventions based on the theory of planned behavior.* University of Massachusetts Amherst. https://people.umass.edu/aizen/pdf/tpb.intervention.pdf

Allen, H., & Nolmark, H. (2022). Active transportation, the ultimate low carbon way to travel—A review of international research and education. *Frontiers in Sustainable Cities, 4*, 824909. https://doi.org/10.3389/frsc.2022.824909

Concha, Y., Arévalo-Gómez, A., Cancino-Pizarro, M., Guzmán-Muñoz, E., & Díaz-Martínez, X. (2024). Influence of active commuting on cardiorespiratory fitness in schoolchildren. *Retos, 58*, 1022–1029. https://doi.org/10.47197/retos.v58.105660

Atikoh, N., Suci, N. R., Mubarok, M. R., & Fuad, M. Y. N. (2024). The role of youth as agents of change in realizing sustainable development goals: A humanistic theory perspective. In *Proceedings of the International Conference of Religion, Health, Education, Science and Technology* (pp. 415–419). https://doi.org/10.35316/icorhestech.v1i1.5668

Baena-Morales, S., & González-Víllora, S. (2022). Physical education for sustainable development goals: Reflections and comments for contribution in the educational framework. *Sport, Education and Society, 28*(6), 697–713. https://doi.org/10.1080/13573322.2022.2045483

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., Carty, C., Chaput, J., Chastin, S., Chou, R., Dempsey, P. C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C. M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P. T., … Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine, 54*(24), 1451–1462. https://doi.org/10.1136/bjsports-2020-102955

Buttazzoni, A., Pham, J., Zhong, S., Ferguson, K. N., & Gilliland, J. (2024). Do environmental attitudes predict perceived active school travel barriers, facilitators, and motivations among youth? Evidence from a national Canadian survey. *Journal of Transport & Health, 39*, 101930. https://doi.org/10.1016/j.jth.2024.101930

Camargo, E. M. D., Silva, M. P. D., Mota, J., & Campos, W. D. (2020). Prevalence and factors associated with active transportation to school for adolescents. *Revista de Saúde Pública, 54*, 78. https://doi.org/10.11606/s1518-8787.2020054002078

Camargo, E. M., López-Gil, J. F., Galvão da Costa, C., de Araujo Bacil, E. D., & de Campos, W. (2024). *Development and validation of an instrument to assess adolescents' perceived barriers to active commuting to school* [Desarrollo y validez de un instrumento para evaluar las barreras percibidas por los adolescentes para desplazarse activamente a la escuela]. *Retos, 60*, 332–340. https://doi.org/10.47197/retos.v60.107331

Campos-Garzón, P., Saucedo-Araujo, R. G., Sevil-Serrano, J., Migueles, J. H., Barranco-Ruiz, Y., & Chillón, P. (2023). A systematic review in device-measured physical activity during active commuting to/from school: Practical considerations to assess when, where, and how much it occurs. *Transport Reviews, 43*(5), 888–913. https://doi.org/10.1080/01441647.2023.2175276

Cieśla, M., & Macioszek, E. (2022). The perspective projects promoting sustainable mobility by active travel to school on the example of the Southern Poland region. *Sustainability, 14*(16), 9962. https://doi.org/10.3390/su14169962

Dai, J., & Menhas, R. (2020). Sustainable development goals, sports and physical activity: The localization of health-related sustainable development goals through sports in China: A narrative review. *Risk Management and Healthcare Policy, 13*, 1419–1430. https://doi.org/10.2147/rmhp.s257844

Derigny, T., Gandrieau, J., Mekkaoui, L., Llena, C., Schnitzler, C., & Potdevin, F. (2024b). Take a ride on a lifelong journey! A physical literacy school-based intervention to safely engage adolescents in active transport. *Journal of Teaching in Physical Education*, 1–10. https://doi.org/10.1123/jtpe.2023-0356

Derigny, T., Mekkaoui, L., Rodrigo-Sanjoaquín, J., Meistermann, L., Gandrieau, J., Schnitzler, C., & Potdevin, F. (2024a). Enhance physical activity through school-based active transport

interventions: A systematic review and meta-analysis. *Journal of Physical Education and Sport, 24*(11), 1542–1554. https://doi.org/10.7752/jpes.2024.11280

Derigny, T., Schnitzler, C., Remmers, T., Van Kann, D., Gandrieau, J., Seye, N., & Potdevin, F. (2022). Catch me if you can! How French adolescents seize social occasions and opportunities to be active. *BMC Public Health, 22*(1), 1332. https://doi.org/10.1186/s12889-022-13746-0

Ding, D., Luo, M., Infante, M. F. P., Gunn, L., Salvo, D., Zapata-Diomedi, B., Nguyen, B. (2024). The co-benefits of active travel interventions beyond physical activity: A systematic review. *The Lancet Planetary Health, 8*(10), e790–e803. https://doi.org/10.1016/S2542-5196(24)00201-8

González, S. A., Sarmiento, O. L., Lemoine, P. D., Larouche, R., Meisel, J. D., Tremblay, M. S., Naranjo, M., Broyles, S. T., Fogelholm, M., Holguin, G. A., Lambert, E. V., & Katzmarzyk, P. T. (2020). Active school transport among children from Canada, Colombia, Finland, South Africa, and the United States: A tale of two journeys. *International Journal of Environmental Research and Public Health, 17*(11), 3847. https://doi.org/10.3390/ijerph17113847

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. https://doi.org/10.1016/S2352-4642(19)30323-2

Hayes, A. F. (2018). Partial, conditional, and moderated moderated mediation: Quantification, inference, and interpretation. *Communication Monographs, 85*(1), 4–40. https://doi.org/10.1080/03637751.2017.1352100

Hinckson, E. (2016). Perceived challenges and facilitators of active travel following implementation of the School Travel-Plan programme in New Zealand children and adolescents. *Journal of Transport & Health, 3*(3), 321–325. https://doi.org/10.1016/j.jth.2016.05.126

Hinckson, E., & Faulkner, G. (2018). School travel plans. In R. Larouche (Ed.), *Children's active transportation* (pp. 205–216). Elsevier.

Ikeda, E., Stewart, T., Garrett, N., Egli, V., Mandic, S., Hosking, J., & Smith, M. (2018). Built environment associates of active school travel in New Zealand children and youth: A systematic meta-analysis using individual participant data. *Journal of Transport & Health, 9*, 117–131. https://doi.org/10.1016/j.jth.2018.04.007

Kim, M. J., & Hall, C. M. (2022). Is walking or riding your bike when a tourist different? Applying VAB theory to better understand active transport behavior. *Journal of Environmental Management, 311*, 114868. https://doi.org/10.1016/j.jenvman.2022.114868

Kline, R. B. (2023). *Principles and practice of structural equation modeling* (5th ed.). The Guilford Press.

Kroesen, M., & De Vos, J. (2020). Does active travel make people healthier, or are healthy people more inclined to travel actively? *Journal of Transport and Health, 16*, 100844. https://doi.org/10.1016/j.jth.2020.100844

Larouche, R., Mammen, G., Rowe, D. A., & Faulkner, G. (2018). Effectiveness of active school transport interventions: A systematic review and update. *BMC Public Health, 18*(1), 206. https://doi.org/10.1186/s12889-017-5005-1

Larouche, R., Saunders, T. J., Faulkner, G. E., Colley, R. C., & Tremblay, M. S. (2014). Associations between active school transport and physical activity, body composition and cardiovascular fitness: A systematic review of 68 studies. *Journal of Physical Activity and Health, 11*(1), 206–227. https://doi.org/10.1123/jpah.2011-0345

Lindqvist, A. K., & Rutberg, S. (2018). One step forward: Development of a program promoting active school transportation. *JMIR Research Protocols, 7*(5), e123. https://doi.org/10.2196/resprot.9505

Mammen, G., Stone, M. R., Faulkner, G., Ramanathan, S., Buliung, R., O'Brien, C., & Kennedy, J. (2014). Active school travel: An evaluation of the Canadian school travel planning intervention. *Preventive Medicine, 60*, 55–59. https://doi.org/10.1016/j.ypmed.2013.12.008

McDonald, N. C. (2007). Active transportation to school: Trends among US schoolchildren, 1969–2001. *American Journal of Preventive Medicine, 32*(6), 509–516. https://doi.org/10.1016/j.amepre.2007.02.022

McDonald, N. C., Deakin, E., & Aalborg, A. E. (2010). Influence of the social environment on children's school travel. *Preventive Medicine, 50*, S65–S68. https://doi.org/10.1016/j.ypmed.2009.08.016

McDonald, N. C., Steiner, R. L., Lee, C., Rhoulac Smith, T., Zhu, X., & Yang, Y. (2014). Impact of the Safe Routes to School program on walking and bicycling. *Journal of the American Planning Association, 80*(2), 153–167. https://doi.org/10.1080/01944363.2014.956654

Mizdrak, A., Blakely, T., Cleghorn, C. L., & Cobiac, L. J. (2019). Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: A modelling study. *PLOS ONE, 14*(7), e0219316. https://doi.org/10.1371/journal.pone.0219316

Sáez Padilla, J., Cantonero, J. M., Moreno, E., Molina, J., & Tornero, I. (2022). *Benefits and barriers of active commuting to school: A systematic review* [Beneficios y barreras del desplazamiento activo hacia el centro escolar: Una revisión sistemática]. *Retos, 43*, 572–578. https://doi.org/10.47197/retos.v43i0.89075

Pang, B., Kubacki, K., & Rundle-Thiele, S. (2017). Promoting active travel to school: A systematic review (2010–2016). *BMC Public Health, 17*(1), 638. https://doi.org/10.1186/s12889-017-4648-2

Power, C., & Fitzpatrick, P. (2023). Child and adolescent patterns of commuting to school. *Preventive Medicine Reports, 36*, 102404. https://doi.org/10.1016/j.pmedr.2023.102404

Rakić, J. G., Hamrik, Z., Dzielska, A., Felder-Puig, R., Oja, L., Bakalár, P., & Ng, K. (2024). *A focus on adolescent physical activity, eating behaviours, weight status and body image in Europe, Central Asia and Canada: Health Behaviour in School-aged Children international report from the 2021/2022 survey (Vol. 4).* https://iris.who.int/handle/10665/376772

Roaf, E., Larrington-Spencer, H., & Lawlor, E. R. (2024). Interventions to increase active travel: A systematic review. *Journal of Transport & Health, 38*, 101860. https://doi.org/10.1016/j.jth.2024.101860

Rodriguez, N. M., Arce, A., Kawaguchi, A., Hua, J., Broderick, B., & Winter, S. J. (2019). Enhancing safe routes to school programs through community-engaged citizen science: Two pilot investigations in lower density areas of Santa Clara County, California, USA. *BMC Public Health, 19*, 256. https://doi.org/10.1186/s12889-019-6563-1

Ruiz-Alarcón, A., Herrador-Colmenero, M., Aranda-Balboa, M. J., Gálvez-Fernández, P., Saucedo-Araujo, R. G., Queralt, A., & Huertas-Delgado, F. J. (2025). Association between the built environment characteristics and the parental perceived barriers towards active commuting to school. *Retos, 68*, 1591–1603. https://doi.org/10.47197/retos.v68.115960

Safe Routes to School National Partnership. (n.d.). *The decline of walking and bicycling.* In *SRTS guide.* http://guide.saferoutesinfo.org/introduction/the_decline_of_walking_and_bicycling.cfm

Sallis, J. F., Owen, N., & Fisher, E. B. (2015). Ecological models of health behavior. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), Health behavior: Theory, research, and practice (5th ed., pp. 43–64). Jossey-Bass.

Salvo, D., Garcia, L., Reis, R. S., Stankov, I., Goel, R., Schipperijn, J., & Pratt, M. (2021). Physical activity promotion and the United Nations Sustainable Development Goals: Building synergies to maximize impact. *Journal of Physical Activity and Health, 18*(10), 1163–1180. https://doi.org/10.1123/jpah.2021-0413

Savolainen, E., Lindqvist, A. K., Mikaelsson, K., Nyberg, L., & Rutberg, S. (2024). Children's active school transportation: An international scoping review of psychosocial factors. *Systematic Reviews, 13*(1), 47. https://doi.org/10.1186/s13643-023-02414-y

Scharoun Benson, S. M., Bruner, B., & Mayer, A. (2020). Encouraging active transportation to school: Lessons learned from implementing a walking school bus program in Northeastern Ontario. *Journal of Transport & Health, 19*, 100914. https://doi.org/10.1016/j.jth.2020.100914

Schönbach, D. M., Brindley, C., Reimers, A. K., Marques, A., & Demetriou, Y. (2020). Socio-demographic correlates of cycling to school among 12- to 15-year-olds in Southern Germany. *International Journal of Environmental Research and Public Health, 17*(24), 9269. https://doi.org/10.3390/ijerph17249269

Simons, D., Clarys, P., De Bourdeaudhuij, I., De Geus, B., Vandelanotte, C., & Deforche, B. (2013). Factors influencing mode of transport in older adolescents: A qualitative study. *BMC Public Health, 13*, 323. https://doi.org/10.1186/1471-2458-13-323

Simons, D., De Bourdeaudhuij, I., Clarys, P., De Cocker, K., De Geus, B., Vandelanotte, C., & Deforche, B. (2017). Psychosocial and environmental correlates of active and passive transport behaviors in college-educated and non-college-educated working young adults. *PLoS ONE, 12*(3), e0174263. https://doi.org/10.1371/journal.pone.0174263

United Nations, Department of Economic and Social Affairs, Population Division. (2019). *World population prospects 2019: Highlights* (ST/ESA/SER.A/423). United Nations. https://population.un.org/wpp/assets/Files/WPP2019_Highlights.pdf

Verhoeven, H., Simons, D., Van Dyck, D., Van Cauwenberg, J., Clarys, P., De Bourdeaudhuij, I., & Deforche, B. (2016). Psychosocial and environmental correlates of walking, cycling, public transport and passive transport to various destinations in Flemish older adolescents. *PLoS ONE, 11*(1), e0147128. https://doi.org/10.1371/journal.pone.0147128

Wang, X., Conway, T. L., Cain, K. L., Frank, L. D., Saelens, B. E., Geremia, C., Kerr, J., Glanz, K., Carlson, J. A., & Sallis, J. F. (2017). Interactions of psychosocial factors with built environments in explaining adolescents' active transportation. *Preventive Medicine, 100*, 76–83. https://doi.org/10.1016/j.ypmed.2017.04.008

Wex, I., Geserick, M., Leibert, T., Igel, U., Sobek, C., Meigen, C., Kiess, W., & Vogel, M. (2023). Active school transport in an urban environment: Prevalence and perceived barriers. *BMC Public Health, 23*, 557. https://doi.org/10.1186/s12889-023-15464-7

World Health Organization. (2009). *Global Physical Activity Questionnaire (GPAQ): Analysis guide.* World Health Organization. https://www.who.int/ncds/surveillance/steps/resources/GPAQ_Analysis_Guide.pdf

World Health Organization. (2019). *Global action plan on physical activity 2018–2030: More active people for a healthier world.* World Health Organization. https://www.who.int/publications/i/item/9789241514187

Authors and translators' details:

Laima Gasiuniene	laima.gasiuniene@yahoo.com	Author
Brigita Mieziene	brigita.mieziene@lsu.lt	Author
Kristina Motiejunaite	kristina.motiejunaite@lsu.lt	Author