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Social inequalities hamper pro-environmental mobility intentions in Europe

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ABSTRACT

Promoting pro-environmental mobility, such as walking, cycling, reducing car usage, and using public transport, can improve population health and create sustainable environments. However, accessibility of resources and socioeconomic status, along with environmental awareness, can affect these behaviors. To explore the impact of socioeconomic status and resident place on awareness and active mobility, we analyzed data from the Eurobarometer 2019 survey (n = 27,498 individuals aged over 14 years) using structural equation modeling. We focused on the association between socioeconomic status (subjective social class, education, economic issues) and community size (rural, small urban, large urban areas) with pro-environmental awareness and intentions in the European Union. Pro-environmental awareness partially mediated the relationship between socioeconomic status and intentions for pro-environmental mobility, such as using car alternatives, reducing unnecessary car trips, and improving public transport. Socioeconomically disadvantaged groups (with low education, social class, and economic issues) reported lower awareness and intentions, while community size had minimal influence ($0 < \beta < 0.1$). Moreover, a social gradient in pro-environmental active mobility intentions was observed across European countries. These findings highlight the need for public health policies to address social and economic inequalities and promote environmental awareness to encourage alternative active mobility options among disadvantaged individuals.

1. Introduction

An active and sustainable daily mobility pattern, such as walking and cycling, is a vital component of pro-environmental action. It improves physical activity levels, air quality, and overall population and planetary health (Cohen et al., 2014; Giles-corti et al., 2022; Zhao et al., 2021). With climate change and increasing global temperatures, international alliances have emerged to defend the planet and human health in a sustainable manner, specifically targeting the reduction of urban pollution. Transport-related emissions contribute to one-quarter of total greenhouse gas emissions (Frumkin & Haines, 2019). In addition to technological innovations related to greener energy and hybrid or electric cars (though their energy sources may still be partially polluting), alternative and sustainable modes of transportation, such as walking, cycling, and public transport, have gained significant importance for health, the environment, and society. Promoting active mobility would increase physical activity during travel, leading to improved physical and mental health, reduced risk factors (e.g., body mass index or cholesterol), lower comorbidity risk, and decreased premature all-cause mortality (Barr et al., 2016; Boniface et al., 2015; Zhao et al., 2021). Indirectly, shifting the proportion of private and polluting modes of transport to active and sustainable ones would enhance air quality, benefiting respiratory health (Barr et al., 2016; Boniface et al., 2015; Cohen et al., 2014; Giles-Corti et al., 2016). However, there is ongoing debate about how to effectively promote daily sustainable commuting and the various factors that drive pro-environmental mobility.

Understanding the factors that influence active and sustainable mobility and how they interact is crucial. Diverse factors, including geographical and urban built environmental characteristics, individual pro-environmental attitudes, awareness, intentions, and socio-cultural and economic backgrounds, can either hinder or promote active mobility (Giles-Corti et al., 2016; Papas et al., 2007; van Valkengoed et al., 2022). For instance, psychosocial factors related to the environment, awareness of issues like climate change, and intentions to address them through pro-environmental attitudes are precursors to adopting actual active and sustainable mobility behaviors (van Valkengoed et al., 2022). Moreover, higher levels of education, social status, and income empower individuals, granting access to information, enhancing critical thinking skills, and fostering trust in science and medical advice (Cutler

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& Lleras-Muney, 2010; McCartney et al., 2019). These socio-economic characteristics, considered social determinants of health, are also associated with lifestyle and environmental behaviors, as well as greater access to resources and services necessary for adopting healthy lifestyle choices (Marmot, 2005a). The impact of social inequalities on population health and well-being is well-documented (Marmot, 2015). Compared to rural areas or smaller communities, large urban areas tend to concentrate the majority of human, economic, and infrastructure resources, including cycling and walking paths and public transport systems (Balland et al., 2020; Carlson et al., 2018; Dyck et al., 2011; Sallis et al., 2012). However, the extent to which these socioeconomic and geodemographic inequalities influence environmental awareness and intentions remains unknown.

Therefore, the present study aimed to: (1) summarize existing evidence on active mobility, health, socioeconomic status, lifestyle, community size, built environment, and psychological factors such as beliefs, awareness, attitudes, intentions, and behaviors; and (2) analyze the relationship between pro-environmental awareness, intention for active mobility, socioeconomic status, and size of community using a representative sample from surveys conducted in Europe.

2. Literature review

Active mobility, which involves physically active modes of transportation like walking or cycling, plays a critical role in addressing both climate change challenges and population health (Pisoni et al., 2022). Encouraging active mobility not only reduces carbon emissions and traffic congestion but also promotes physical activity, leading to improved health outcomes (Koszowski et al., 2019). By incorporating active mobility into daily commuting, individuals could meet the World Health Organization's recommended weekly physical activity guidelines of at least 150 min of moderate-to-vigorous activity (World Health Organization, 2020; World Health Organization - Regional Office for Europe, 2022). Regular physical activity has been also associated with a lower body mass index, decreased risk of chronic diseases, and improved mental well-being (Warburton & Bredin, 2016). However, several factors contribute to the decline of active mobility, including urban planning that prioritizes car-centric infrastructure, sedentary lifestyles, inadequate pedestrian and cycling infrastructure, and a culture that favors motorized transportation (Koszowski et al., 2019), which poses health risks, particularly in urban environments where commuting takes up a significant amount of time (Stefansdottir et al., 2019). Public transportation, despite being a motorized mode of travel, can also promote an active lifestyle by involving walking or cycling for a significant portion of the population in large cities (Fairnie et al., 2016). Regular use of buses, trams, or metros can add 8 to 33 extra minutes of walking per day (Rissel et al., 2012). Therefore, investing in public infrastructure for active mobility and reducing car usage are essential steps towards promoting public health in the future.

Active mobility is also a fundamental human behavior involved in meeting our daily needs. Various psychological aspects, such as personal beliefs, individual norms, subjective social norms, attitudes, and intentions, play a role in the manifestation or absence of this behavior (van Valkengoed et al., 2022). One widely used psychological theory is Ajzen's theory of planned behavior (Ajzen, 1991). Briefly, the theory states that behavior is performed when individuals have the intention or predisposition to do so, which is a prerequisite for engaging in active and sustainable mobility behavior (Ajzen, 1991). This prior intention is influenced by three interconnected factors: attitude towards the behavior (perception of its advantages or disadvantages to individuals and their interests), subjective and social norms (social pressures or external judgments on socially accepted or rejected behaviors), and perceived control over behavior performance (considering individual capabilities and task difficulty) (Ajzen, 1991). These three factors are associated with individuals' beliefs, social beliefs, or awareness of the direct and indirect benefits or detriments of engaging or not engaging in the behavior for themselves and the community (Ajzen, 1991). This concept is known as health literacy in health-related behaviors. Interventions targeting health literacy by increasing participants' awareness of the health benefits and risks of certain behaviors, such as diet or physical activity, and providing strategies for gaining a sense of control can enhance the intention to engage in those behaviors (van Valkengoed et al., 2022). Notably, individuals with higher levels of education tend to have greater health literacy (Cutler & Lleras-Muney, 2010; Hofer-Fischanger et al., 2020). Studies have shown a positive association between higher educational attainment and increased health literacy in rural Austria (Hofer-Fischanger et al., 2020). However, when it comes to active mobility, such as walking and cycling, the focus shifts towards environmental factors such as path availability, connectivity, and distances, rather than health literacy (Hofer-Fischanger et al., 2020). Another study in Brazil based on the theory of planned behavior found that perceived control and attitude towards walking were the main predictors, while subjective social norms showed no significant association (Neto et al., 2020). Interestingly, research conducted in China suggests that lower socioeconomic classes exhibit less behaviors of caring the environment compared to their higher socioeconomic counterparts, despite having similar levels of environmental awareness (Flatø, 2020). In a small sample of Norwegian university students, subjective social norms emerged as the primary predictor of active mobility, with individual norms and environmental attitudes having no significant effect (Fallah Zavareh et al., 2020). Notably, this study did not find a mediating role of attitudes between motives and active mobility, although it did influence travel time (Fallah Zavareh et al., 2020). These findings indicate that while attitudes, awareness, and intentions are important, other socioenvironmental factors also play a role. However, a systematic review highlights the need to consider the determinants of behaviors when designing interventions to promote pro-environmental behaviors (van Valkengoed et al., 2022). As mentioned above, this involves psychological factors such as perception, beliefs, attitudes, norms, emotions, knowledge, risk perception, problem awareness, self-efficacy, and responsibility. In the case of active-passive mobility, broader domains such as socioeconomic and environmental determinants need to be considered, as they can impact behavior outcomes beyond easily achievable pro-environmental actions like recycling.

Socioeconomic status, along with the previously mentioned increased health literacy, plays a crucial role in determining access to resources and overall well-being. It significantly influences individuals' awareness and ability to prioritize health-related aspects of their lifestyle (García-Mayor et al., 2021). Those from higher socioeconomic backgrounds tend to have better access to healthcare, nutritious food, and recreational facilities, enabling them to lead healthier lives. This often translates into higher levels of physical activity and active mobility, as they have the means and opportunities to engage in active modes of transportation (Timperio et al., 2004; Tung et al., 2016). In contrast, individuals from lower socioeconomic backgrounds may face barriers such as limited financial resources, lack of knowledge or awareness about healthy lifestyle choices, and inadequate infrastructure for physical activity (Giles-Corti et al., 2016; Meyer et al., 2016; Parks et al., 2003; Seguin et al., 2014). The impact of educational level and social class on attitudes towards the environment cannot be overstated (Berthe & Elie, 2015). Societies characterized by greater socioeconomic equality, fostering mutual trust and civic behavior, are more likely to advocate for environmental policies. Higher levels of education significantly deepen comprehension of environmental issues and enhance the sense of urgency in addressing them (Berthe & Elie, 2015). Individuals with advanced education are more aware of the ecological repercussions of their actions, leading them to make informed choices that effectively reduce their environmental impact (Berthe & Elie, 2015). Moreover, social class plays a significant role in shaping environmental attitudes (Pickett & Wilkinson, 2010). Affluent individuals often have the financial means to adopt environmental-friendly practices, such as active mobility or purchasing eco-friendly products (Berthe & Elie, 2015; Kennedy & Givens, 2019). Conversely, individuals from lower social classes may prioritize immediate economic concerns over long-term environmental sustainability, highlighting the importance of addressing socioeconomic disparities to facilitate the widespread adoption of environmentally conscious behaviors (Kennedy & Givens, 2019).

Active mobility is influenced by the built environment, including the typology of the resident place. By 2050, it is projected that 70 % of the global population will reside in urban environments, which contribute to 85 % of greenhouse gas emissions, with transportation accounting for 24 % (Frumkin & Haines, 2019; Giles-Corti et al., 2016; Ritchie, 2018). Urban areas concentrate crucial resources such as human capital, economic opportunities, healthcare, education, and infrastructure, often at the expense of neglecting rural or smaller population areas (Balland et al., 2020; Lagakos, 2020). Overcrowding in cities leads to issues such as poor air quality and increased noise pollution, which hinder active and sustainable mobility (Giles-corti et al., 2022). Conversely, rural areas face challenges of limited resources, underfunding, and a lack of qualified human resources, which impede community development, access to goods and services, and infrastructure for active mobility (Lagakos, 2020). As we consider the size of the community within the residential environment, other factors related to the built environment come into play. Factors such as connectivity, circulation network design, population density, distance between destinations, walkability, cyclability, public transport, housing diversity, mixed land use, green spaces, safety, and traffic calming play a role in urban or place planning for active mobility (Giles-Corti et al., 2016; Giles-corti et al., 2022;Mertens et al., 2017; Smith et al., 2017; Zhang et al., 2022). For instance, individuals living in environments that facilitate active mobility with proximity to bus stops and parks are 80 % more likely to walk and 50 % more likely to meet the World Health Organization's physical activity guidelines through walking-related transportation alone (Giles-corti et al., 2022). Systematic reviews indicate positive effects of remodeling and improving the quality, availability, and access to parks, trails, and bike paths, as well as implementing 30 km/h speed limits and ensuring safety and connectivity (Mertens et al., 2017; Smith et al., 2017; Zhang et al., 2022). These measures promote transport-related physical activity, lower body mass index, and reduce obesity (Mertens et al., 2017; Smith et al., 2017; Zhang et al., 2022). Public transport, such as buses, can also increase walking time and promote active lifestyles, potentially adding 16 min of walking per day and increasing the proportion of active individuals by 6.97 % if promoted among the inactive population (Passi-Solar et al., 2020; Rissel et al., 2012). However, there is limited evidence regarding associations with lower obesity, diabetes, or hypercholesterolemia. It is crucial to promote physical activity and active mobility across all socioeconomic groups, particularly among those who are more disadvantaged. Higher education, economic income, and white-collar occupations are associated with a greater likelihood of walking (Turrell et al., 2014). Conversely, individuals with lower socioeconomic status often reside in suburban or peripheral areas with longer distances and poor-quality public transport (Convery & Williams, 2019; Marmot, 2005b). Neighborhood socioeconomic status can also influence walkability and physical activity levels, with higher socioeconomic neighborhoods displaying better walkability (Sallis et al., 2016). While higher socioeconomic statuses tend to have higher car ownership rates, the built environment still plays a significant role in active and sustainable mobility choices for these groups (Sugiyama et al., 2019). The resulting promotion of transport-related physical activity could lead to savings of €15 billion in Europe, benefiting pollution reduction, air quality improvement, physical activity levels, and overall health outcomes (Pisoni et al., 2022).

In summary, the evidence is extensive in various areas related to active mobility, human and planetary health, the built environment, socioeconomic status, and psychological factors. However, there are still gaps in knowledge, particularly regarding how different socioeconomic groups and community size are associated with environmental awareness and intentions for active mobility. Further research is needed to obtain a more comprehensive understanding of the phenomenon. This is the case of how different socioeconomic groups or socioeconomic inequalities (mainly by educational level, social class, and economic issues) and differences in environments (e.g., by the size of the community) are associated with environmental awareness and then intentions for active mobility, just the step before developing active and sustainable mobility behaviors. Additionally, previous studies have primarily focused on national contexts, and more evidence is required from international contexts to enhance the generalizability of the findings. The European Union, as a high-income region and a significant contributor to pollution, has the potential to play a crucial role in promoting active and sustainable mobility, but further evidence is needed to support policy and intervention development.

In our study, we analyzed the intentions of the European population regarding active mobility, considering major socioeconomic conditions such as educational level, social class, and economic issues, as well as the size of the community. We used data from the Eurobarometer 92.4 (2019) cross-sectional survey. Additionally, we examined whether these socioeconomic status and size of community indicators were associated with pro-environmental awareness. Furthermore, we explored the possibility that pro-environmental awareness could mediate the relationship between these social determinants and intentions towards active mobility. This study aims to provide valuable evidence regarding pro-environmental behavior in relation to active mobility in two significant aspects: (1) understanding the distribution and influence of pro-environmental awareness across the European Union based on social determinants, and (2) examining whether social determinants still play a role in shaping pro-environmental intentions, even among individuals with pro-environmental awareness.

3. Methods

The present study followed the guidelines outlined in the STROBE Statement for cross-sectional studies (STROBE Statement, 2008).

3.1. Data

We utilized data from the cross-sectional survey conducted by Eurobarometer 92.4 in December 2019 (doi:https://doi.org/10.4232/1.13652) (European Commission, 2020). The survey included a sample of 27,498 individuals aged over 14 years from the 28 European Union countries (Women: $n = 14{,}880$, 54.1 %; Men: $n = 12{,}618$, 45.9 %). The mean age of the participants was 51.8 years ($SD = 18.2$; $Range = 15–98$). Each member state contributed a representative sample of approximately 1000 participants, selected through a stratified random probability methodology that considered factors such as population size, population density, age, gender, region, and region size. Trained professionals conducted face-to-face interviews, randomly selecting one potential candidate from each household. Since our study relied on anonymized secondary databases, ethical approval and informed consent were not required.

3.2. Variables

Pro-environmental mobility intentions were measured using three dichotomous questions (*Yes* or *not*) that assessed participants' intentions over the past six months: (1) choosing a more environmentally-friendly mode of travel (e.g., walking, cycling, public transport, or electric car) ($n = 7634$, 27.8 %); (2) using their car less, working from home, etc. ($n = 5166$, 18.8 %); and (3) willingness to share personal information to improve public transport ($n = 7056$, 25.7 %). Additionally, participants' environmental awareness was assessed through three questions: (1) how important is protecting the environment to you personally? (*very/fairly important* [$n = 25{,}827$, 94.3 %] or *not very/not at all important* [$n = 1562$, 5.7 %]); (2) environmental issues have a direct effect on your daily life and health (*totally/tend to agree* [$n = 21{,}369$, 79.2 %] or *totally/tend to disagree* [$n = 5608$, 20.8 %]); and (3) how serious a problem do you think climate change is at this moment? (range of 0–3 equals to *not a serious problem* [$n = 1729$, 6.5 %] or range of 4–9 equals to *a fairly/very serious problem* [$n = 24{,}755$, 93.5 %]).

Socioeconomic status was assessed based on educational level, subjective social class, and household economic issues. Educational level was categorized into four groups based on the age at which participants completed full-time education using the following question: How old were you when you stopped full-time education? The responses were as follows: *up to 15 years* ($n = 3812$, 14.1 %), *16 to 19 years* ($n = 11{,}932$, 44.1 %), *20 years and older* ($n = 9631$, 35.6 %), and *still studying* ($n = 1675$, 6.2 %). Subjective social class was self-reported using the following question: Do you see yourself and your household belonging to…? into five response options as *the working class of society*, *the lower middle class*, *the middle class*, *the upper middle class*, and *the higher class*. We reclassified *the upper middle class* into *the higher class* and *the lower middle class* into *the working class* (Chan & Goldthorpe, 2007; Domingo-Salvany et al., 2013). Thus, the three social classes were: *the higher class* ($n = 2043$, 7.7 %), *the middle class* ($n = 11{,}396$, 43.1 %), and *the working class of society* ($n = 12{,}992$, 49.2 %). Economic status was self-reported based on household difficulties in paying bills in the last year using the following question: During the last twelve months, how often have you had difficulties in paying your bills at the end of the month…? The response options were *most of the time* ($n = 2109$, 7.8 %), *from time to time* ($n = 6654$, 24.5 %), and *almost never or never* ($n = 18{,}364$, 67.7 %).

The size of the community was classified according to the European Commission's 2014 classification into *rural* ($n = 7777$, 28.3 %), *small urban* ($n = 8904$, 32.4 %), and *large urban areas* ($n = 10{,}817$, 39.3 %) (Dijkstra & Poelman, 2014). The classification of the three types of environments was determined by analyzing a population grid consisting of 1 km^2 cells. These cells were categorized based on their population density, gradually assigning them to specific types. Urban areas were identified as high-density regions where at least 50 % of the population resided in high-density clusters. Suburban areas were characterized as middle-density regions where <50 % of the population lived in rural grid cells and <50 % in a high-density cluster. Rural areas, on the other hand, were defined as low-density regions where >50 % of the population resided in rural grid cells.

3.3. Statistical analysis

We performed several multilevel binomial logistic regressions adjusted by age and gender with random intercepts by country. First, we assessed the association of socioeconomic status and size of community with the three pro-environmental mobility intentions with and without controlling for environmental awareness. These logistic regressions were conducted separately for each pro-environmental intention. Second, we analyzed the association of socioeconomic status and size of community with environmental awareness. Socioeconomic status and the size of community were separately included in the logistic regressions and pro-environmental awareness was a dichotomous variable which were defined as answering *very/fairly important*, *totally/tend to disagree*, or *a fairly/very serious problem* in at least one of the pro-environmental awareness variables. Additionally, we employed structural equation modeling analyses, separately per each pro-environmental intention, both with and without controlling for age and gender, using the *sem* function from the *lavaan* in Rstudio Version 3.6.1 (Rstudio, Inc., Boston, MA, USA). Structural equation modeling allowed us to decompose the total effect of, for example, socioeconomic status on pro-environmental active mobility intention, into the indirect effect (the effect of exposure transmitted to the outcome using intermediate variables or mediators) and the direct effect (the remaining effect of exposure on the outcome directly or by other unobserved factors). All employed variables were introduced as continuous from low to higher values. Thus, socioeconomic status latent variable was composed by educational level (0 = *up to 15 years*, 1 = *16 to 19 years*, 2 = *20 years and older*, 3 = *still studying*), subjective social class (0 = *low*, 1 = *middle*, 2 = *high*) and economic wellness in this case (0 = *economic issues most of the time*, 1 = *economic issues from time to time*, 2 = *economic issues almost never or never*). Size of the community were ordered as follows: 0 = *rural area*, 1 = *small urban area*, 2 = *large urban area*. On the other hand, pro-environmental awareness latent variable comprised three ordinal indicators: importance of protecting the environment (from 0 = *Not at all important*; to 3 = *Very important*), environmental issues directly affect human health (from 0 = *Totally disagree*; to 3 = *Totally agree*), and climate change is a serious problem (from 0 = *Not at all serious problem*; to 9 = *An extremely serious problem*). We used bootstrapping with 1000 resamples to compute 95 % confidence intervals (95 % CI) for these models. Various fit indices were calculated for each adjusted and unadjusted structural equation model. Definitions and interpretations of each index is provided in the supplementary material. A sensitivity analysis was performed, using dummy variables for size of the community, educational level, subjective social class, and economic issues, with and without adjustment for age and gender. We also conducted a reevaluation of the relationship between socioeconomic status, community size, and the choice of environmentally-friendly travel modes, as well as reduced car usage and teleworking. This analysis involved multinomial logistic regressions, both with and without controlling for pro-environmental awareness. For the latter, pro-environmental intentions were consolidated into a cross-classified variable comprising four categories. Additionally, we calculated the percentages of environmental awareness and pro-environmental intentions according to educational level, subjective social class, economic issues, size of the community, and European Union country members. Statistical significance was determined at a p-value <0.05.

4. Results

Overall, our results indicated that pro-environmental mobility intentions were less common among individuals with lower educational levels, lower social classes, economic issues, and those residing in small urban and rural areas (Figs. 1–3). Moreover, even after accounting for pro-environmental awareness, higher socioeconomic status remained associated with a greater likelihood of using environmentally friendly travel options, avoiding unnecessary car use, and expressing willingness to improve public transport.

Furthermore, the age- and gender-adjusted structural equation models revealed that pro-environmental awareness partially mediated the relationship between socioeconomic status and size of community with all three pro-environmental mobility intentions (Fig. 4). However, the association with size of community was relatively weak ($0 < \beta < 0.1$). It is important to note that the three models, based on different dependent variables, yielded similar results (Fig. S1), although there were notable differences between adjusted and unadjusted models. Among the 11 fit indices assessed (Table S1), only one index (SRMR, Standardized Root Mean Square Residual) met the satisfactory criteria in the age- and gender-adjusted models. In contrast, the unadjusted models showed satisfactory results for seven indices (GFI, AGFI, NFI, CFI, RMSEA, SRMR, and IFI). Despite these variations in fit indices, the coefficient estimates remained consistent in terms of statistical significance and direction, even when age and gender were not controlled. The association between size of community and pro-environmental intentions did not vary in terms of direct effects (Choosing a more environmental way of travelling: $\beta = 0.057$, $P < 0.001$; Have used your car less: $\beta = 0.020$, $P < 0.001$; Willing to improve public transport: $\beta = 0.047$, $P < 0.001$) or indirect effects (Choosing a more environmental way of travelling: $\beta = 0.008$, $P < 0.001$; Have used your car less: $\beta = 0.006$, $P < 0.001$; Willing to improve public transport: $\beta = 0.008$, $P < 0.001$). On the other hand, the relationships between socioeconomic status and pro-environmental intentions were attenuated both in terms of direct effects (Choosing a more environmental way of travelling: $\beta =$

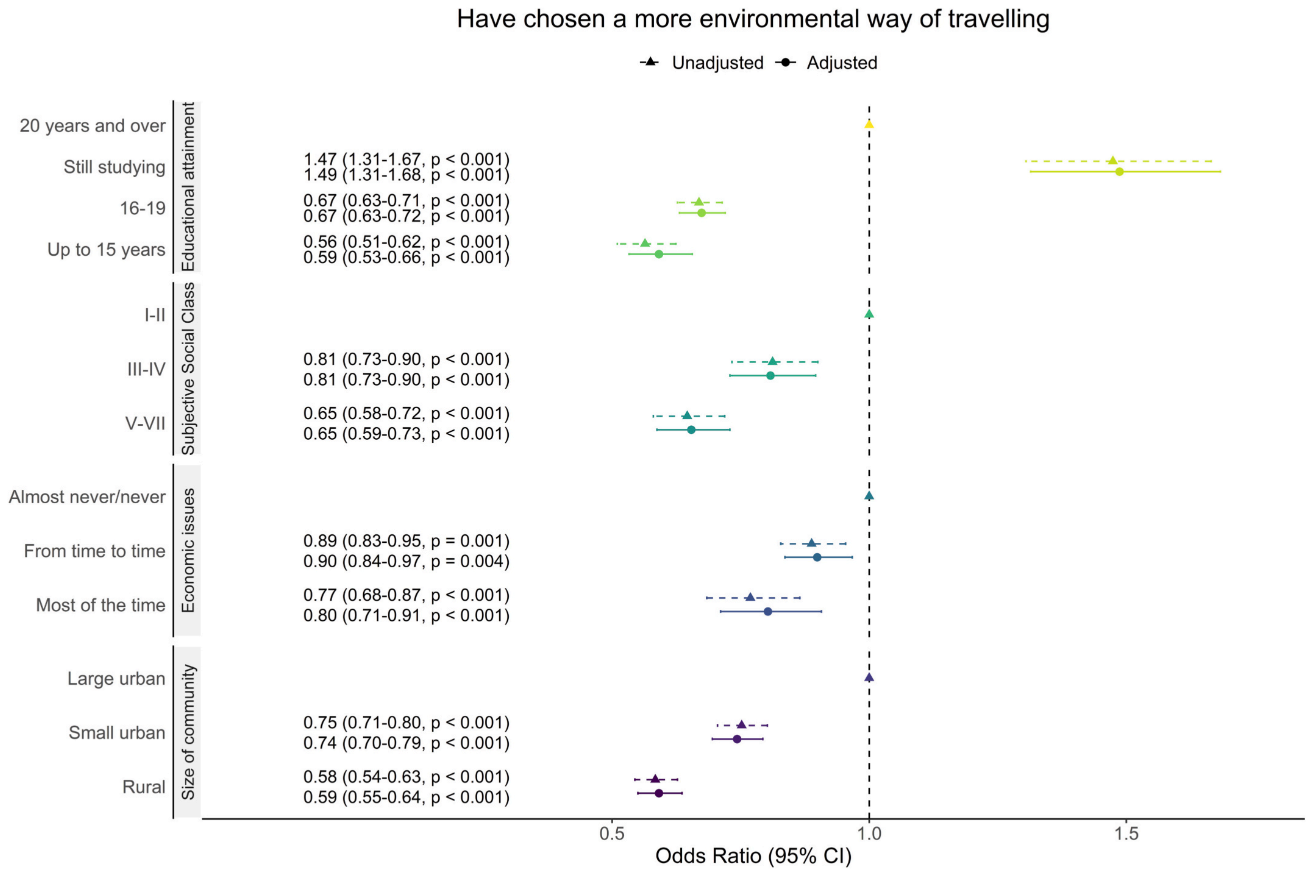

Fig. 1. Social determinants influence pro-environmental intentions across EU-28. Odds ratio (95 % CI) for having chosen a more environmental-friendly way of travelling in the past six months by major social determinants. European Union-28, 2019.

0.264, $P < 0.001$; Have used your car less: $\beta = 0.257$, $P < 0.001$; Willing to improve public transport: $\beta = 0.222$, $P < 0.001$) and indirect effects (Choosing a more environmental way of travelling: $\beta = 0.020$, $P < 0.001$; Have used your car less: $\beta = 0.014$, $P < 0.001$; Willing to improve public transport: $\beta = 0.019$, $P < 0.001$). Moreover, the direct effect of socioeconomic status on pro-environmental intentions was moderate in age- and gender-adjusted estimates for choosing a more environmental way of travelling ($\beta = 0.363$, $P < 0.001$) and having used less the car ($\beta = 0.365$, $P < 0.001$) compared to unadjusted models ($\beta = 0.264$, $P < 0.001$ and $\beta = 0.257$, $P < 0.001$, respectively). Additionally, the strength of the association between environmental awareness and pro-environmental intentions also decreased (Choosing a more environmental way of travelling: $\beta = 0.158$, $P < 0.001$; Have used your car less: $\beta = 0.118$, $P < 0.001$; Willing to improve public transport: $\beta = 0.155$, $P < 0.001$).

Furthermore, we observed a social gradient in pro-environmental mobility intentions across all European countries, with unequal distribution according to major social determinants and the size of the community (Figs. S2–S5). This social gradient was also evident in general pro-environmental awareness, except for the size of the community (Fig. S6). Individuals who completed their full-time education up to 15 years (*OR* = 0.42; *95 % CI* = 0.29–0.61; $P < 0.001$) or 16 to 19 years (*OR* = 0.64; *95 % CI* = 0.48–0.84; $P = 0.001$) were less likely to have pro-environmental awareness compared to those who completed their education at 20 years and older. However, those who were still studying showed no differences in pro-environmental awareness (*OR* = 0.94; *95 % CI* = 0.55–1.61; $P = 0.831$) compared to those who completed their education at 20 years and older. Regarding social class, individuals from lower social classes (V–VII) were less likely to report pro-environmental awareness (*OR* = 0.50; *95 % CI* = 0.30–0.82; $P = 0.007$) compared to higher social classes (I–II), while middle social class (III–IV) showed no significant differences (*OR* = 0.82; *95 % CI* = 0.50–1.36; $P = 0.444$). Additionally, individuals who reported economic issues from time to time (*OR* = 0.51; *95 % CI* = 0.39–0.66; $P < 0.001$) or most of the time (*OR* = 0.27; *95 % CI* = 0.19–0.38; $P < 0.001$) were less likely to have pro-environmental awareness compared to those who almost never or never experienced economic issues. Finally, individuals residing in small urban (*OR* = 1.08; *95 % CI* = 0.83–1.41; $P = 0.552$) or rural (*OR* = 0.99; *95 % CI* = 0.76–1.28; $P = 0.917$) areas did not show significant differences in pro-environmental awareness compared to those living in large urban areas.

In the sensitivity analysis with dummy variables, adjusted and unadjusted structural equation models for choosing eco-friendly travel, reduced car usage, and willingness to share personal data for public transport improvement revealed good fit: 6/11 in adjusted models and 7/11 in unadjusted ones (Table S2). Sensitivity analyses (Tables S3–S5) showed similar estimates for gender and age between the two model types, with adjusted models indicating greater mediator effects on the outcome. Adjusted models demonstrated higher total and direct effects of education on eco-friendly travel (Table S3) and reduced car use (Table S4), but smaller estimates for data sharing willingness (Table S5). Higher education, social class, and urban living (both small and large areas) correlated with increased eco-friendly travel and reduced car use. Economic concerns only affected the total effect, mostly through direct influence. Individuals still studying, with 20+ years of education, middle-class status, and urban residency (small or large areas) displayed indirect effects via environmental awareness.

On the other hand, the sensitivity analysis regarding the combination

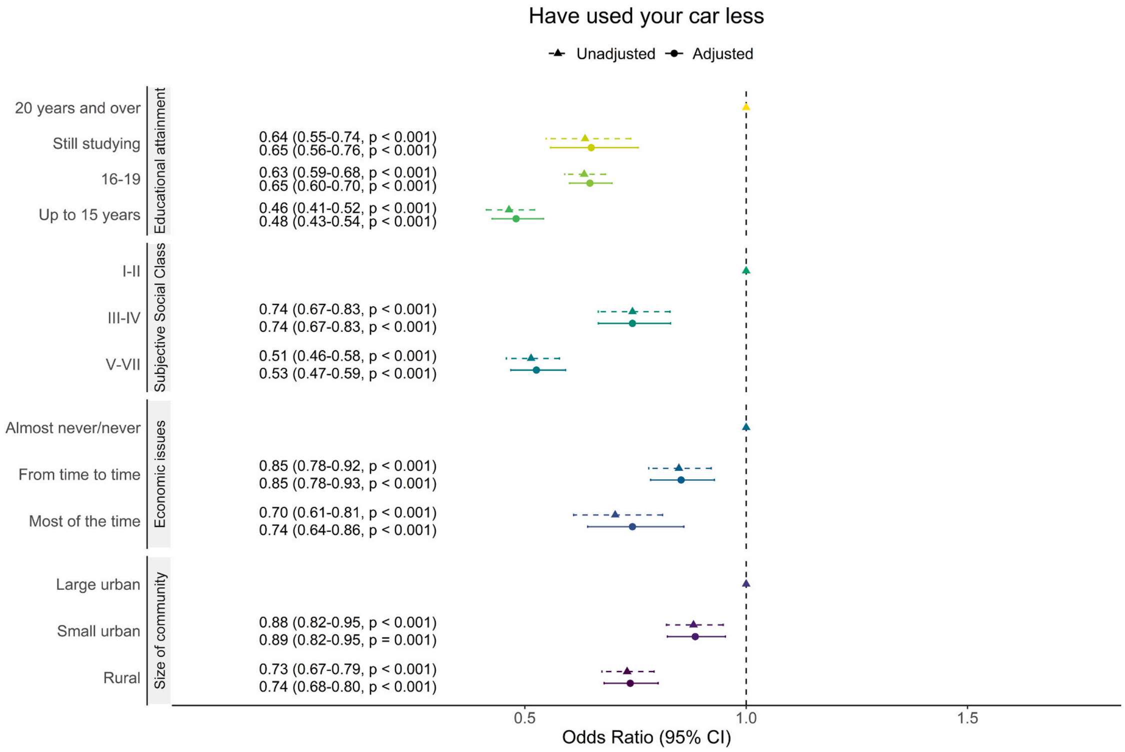

Fig. 2. Social determinants influence pro-environmental intentions across EU-28. Odds ratio (95 % CI) for using car less by avoiding unnecessary trips by major social determinants. European Union-28, 2019.

of adopting a more environmentally-friendly mode of travel, reducing car usage, working from home, and similar measures revealed that individuals with lower socioeconomic status (including those with lower educational attainment, working in lower social classes, and facing more economic challenges) and those residing in smaller urban or rural areas were less likely to report their intentions, both individually and in combination. This trend was observed in both the unadjusted and adjusted models for pro-environmental awareness (see Figs. S7–S8).

5. Discussion

These findings highlight the significance of social determinants, both through their direct effects and indirect effects mediated by pro-environmental awareness, which demonstrated a small association with pro-environmental intentions. In other words, our results indicate that active mobility behavior is influenced by both pro-environmental awareness and socioeconomic status, as previous studies have also reported in relation to other environmental behaviors (Casaló & Escario, 2018; Eom et al., 2018). However, our study adds the important insight that socioeconomic status inequalities in active mobility intentions are mediated through pro-environmental awareness. These social determinants continue to play a significant role in shaping the intention to engage in active mobility through modes such as public transport, cycling, or walking, even when considering environmental awareness. In contrast, the size of the community had a trivial effect in our study.

Higher educational attainment and social class are often associated with critical thinking and health literacy (Cutler & Lleras-Muney, 2010; Marmot, 2005a). On the other hand, disadvantaged individuals are more likely to live in deprived areas with limited access to services such as reliable and high-quality public transport, cycling lanes, and pedestrian walkways (Seguin et al., 2014). Furthermore, environmental awareness has increased, particularly in areas such as recycling, active transportation, and understanding the impact of carbon footprints (Jayadinata et al., 2021). However, even with a considerable level of pro-environmental awareness, socioeconomic status remains a major determining factor. The existing literature provides limited specific evidence on the association between socioeconomic status, size of community, pro-environmental awareness, and active mobility. A study conducted in rural Austria found a link between higher educational attainment and greater health literacy (Hofer-Fischanger et al., 2020). However, active mobility through walking and cycling was associated with environmental factors such as access to walking and cycling paths, connectivity, and distances, rather than health literacy (Hofer-Fischanger et al., 2020). In contrast, in China, lower socioeconomic classes exhibited less concern for the environment compared to higher socioeconomic classes, despite similar levels of environmental awareness (Flatø, 2020). Another study in Brazil revealed that perceived control and attitude were the main predictors of walking behavior, while subjective social norms showed no significant association (Neto et al., 2020). Similarly, a small-scale study involving university students in Norway found that subjective social norms, but not individual norms or environmental attitudes, predicted active mobility (Fallah Zavareh et al., 2020). Interestingly, this study did not find a mediating effect of attitudes between motives and active mobility, but it did observe an influence on travel time (Fallah Zavareh et al., 2020). These findings suggest that while attitudes, awareness, and intentions are important, other socioenvironmental determinants should also be considered. Although our study indicates a trivial effect of size of community, research has consistently shown that rural areas face challenges in implementing community development measures, accessing goods, services, and infrastructure related to active mobility and physical activity due to underfunding and limited human resources (Balland et al., 2020; Lagakos, 2020). Numerous studies have reported that individuals living in rural environments encounter barriers such as limited time, restricted access, longer distances, and fewer opportunities and facilities for walking, cycling, and public transport, often resulting from lower-quality trails, cycle paths, and transportation services (Meyer et al., 2016; Papas et al., 2007). A study reported that a higher socioeconomic

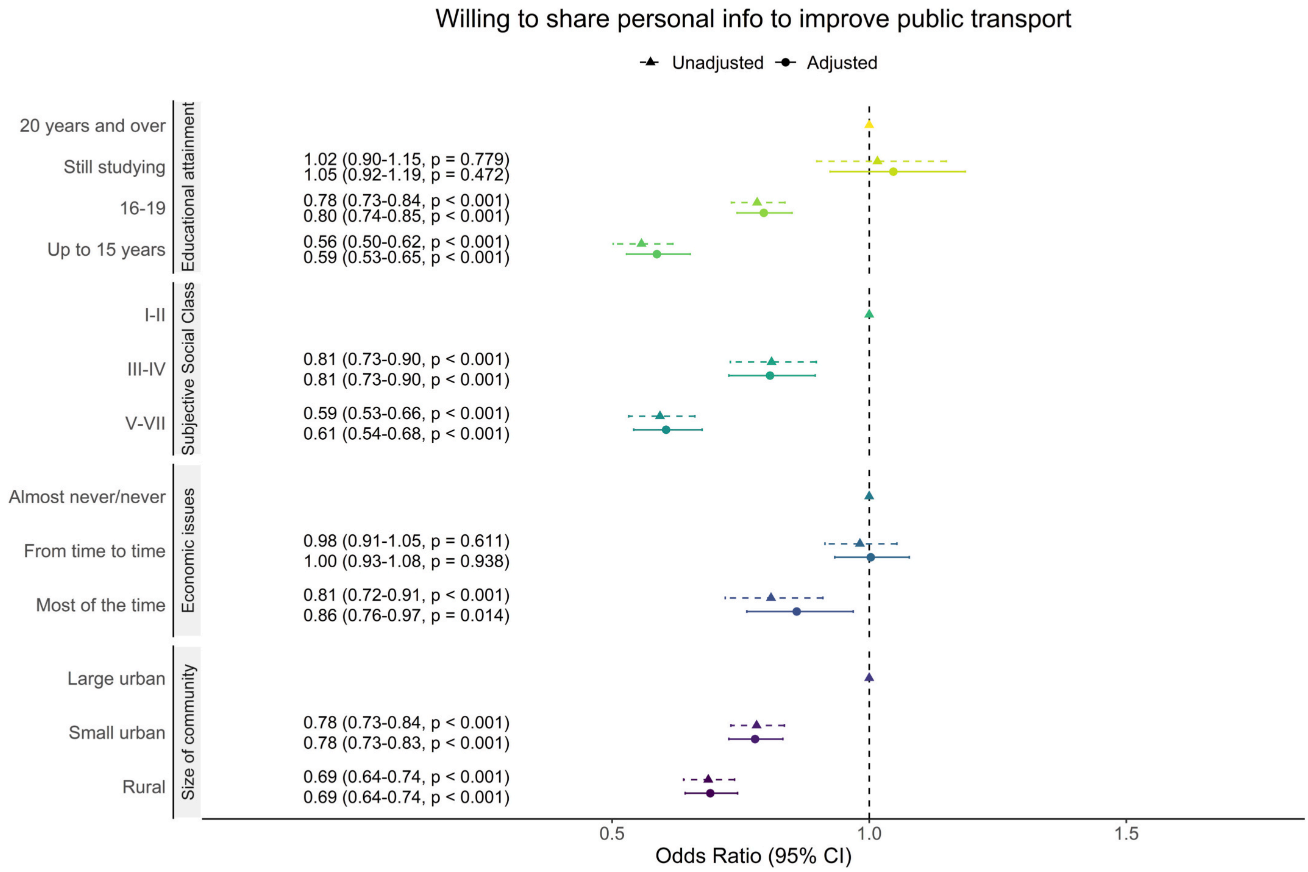

Fig. 3. Social determinants influence pro-environmental intentions across EU-28. Odds ratio (95 % CI) for being willing to share personal information securely to improve public transport and reduce air pollution by major social determinants. European Union-28, 2019.

neighborhood was associated with higher walkability (a composite measure that captures the ease to go walking through the environment) and that its inhabitants had more physical activity walking than those residing in socioeconomically poorer neighborhoods and lower walkability (Sallis et al., 2016). Even though car-owning is conditional on active-passive mobility and more frequent in higher socioeconomic statuses, the built environment may still be associated with greater active and sustainable mobility (Sugiyama et al., 2019).

We should strive to encourage the population to adopt active mobility and promote environmentally friendly attitudes and intentions (Cialdini & Cialdini, 2007). However, without considering socioeconomic inequalities, individuals may not have the necessary resources to make the right choices. Public health policies should focus on human behavior and development, promoting elements that support active mobility, improving access and availability, while also limiting and discouraging harmful options. To improve society, the environment, and population health through active mobility, it is crucial to involve urban planners, transportation authorities, businesses, civic associations, and society. Beyond promoting environmental awareness, efforts should be made to reduce social inequalities in accessing alternative modes of transportation such as cycling and walking, as well as improving public transport systems, their accessibility, and connectivity across urban, transport, business, civic associations, and health sectors. Socially disadvantaged individuals are more likely to reside in deprived settings. Therefore, interventions should prioritize the most socioeconomically deprived areas, which often have lower per capita income, higher unemployment rates, limited public infrastructure, and fewer services. These actions aim to shift the advantages towards active mobility over private car use, creating healthier and more sustainable environments. This approach would not only result in reduced air pollution but also increase physical activity and improve population health, particularly among the most disadvantaged social groups. Despite their significance, socioeconomic factors are often neglected in pro-environmental and active mobility policies.

Some limitations should be considered in our study findings. First, while structural equation models provide insights into causal directions between exposure, mediator, and outcome variables, our survey's observational design and cross-sectional nature only allow for the establishment of associations. Secondly, most variables, particularly those related to awareness and pro-environmental intentions towards active and sustainable mobility, were measured through self-reporting. Self-reported measures can be susceptible to biases including recall bias, leading to both under- and overestimations (Cerin et al., 2016; Hunsberger et al., 2020). When investigating socioeconomic inequalities using self-report measures, overestimations may occur in the upper socioeconomic strata due to compliance or social desirability biases associated with healthy behaviors or socially accepted thoughts (Hunsberger et al., 2020). The subjective measurement of pro-environmental behaviors in active mobility does not imply actual behaviors but rather intentions as the step before developing such behaviors (Ajzen, 1991). Furthermore, the wording of the pro-environmental intention questions does not enable the assessment of pro-environmental intentions over the past 6 months and their current status. Instead, it only allows for the evaluation of relative changes, not absolute levels. Furthermore, the Eurobarometer survey did not assess car ownership or private vehicle ownership, which could provide a more comprehensive understanding of car ownership patterns with active mobility. Other studies suggest that people in higher socioeconomic

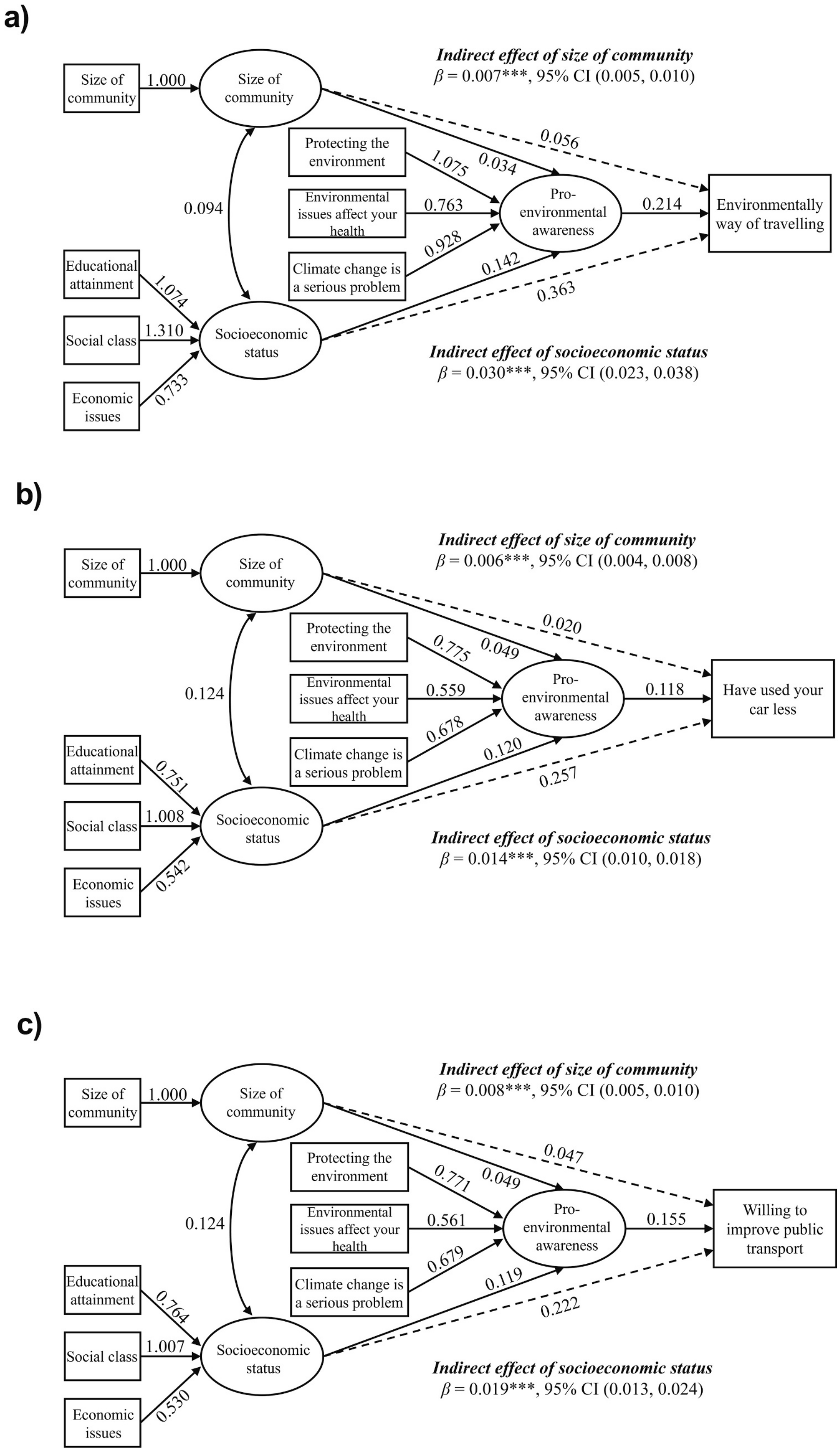

Fig. 4. Pro-environmental awareness mediates in the association between socioeconomic status and size of community with pro-environmental intentions. Standardized beta coefficients and factor loadings of latent variables are presented in the structural equation modeling analyses. All coefficients were highly statistically significant ($P < 0.001$). *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. Structural equation models were adjusted by age (continuous) and gender. European Union-28, 2019.

classes may contribute more to pollution, but they often have greater opportunities for telecommuting, which is in contrast to the lower-income population typically associated with manual labor. (Convery & Williams, 2019). Nevertheless, our sensitivity analysis revealed that individuals with higher socioeconomic status are more inclined to report reduced car usage and/or an increased preference for environmentally friendly modes of transportation. In a hypothetical scenario where the size of the community, environmental awareness, and high socioeconomic status are associated with self-reported intentions for active mobility but not translated into actual active and sustainable behavior, other factors such as the built environment may help explain this potential discrepancy. If applicable, to promote active and sustainable mobility, measures and actions should also be covered built environment aspects such as walkability, land use mix, connectivity in active mobility, and public transport along with aspects of socioeconomic inequality such as accessibility and cost in economic and spatial-temporal resources, safe and attractive as an advantage over passive options. The importance of these measures lies, according to our study, in the direct effect of socioeconomic status but at the same time measures must be implemented to further increase environmental awareness throughout the population. Shifting from private and passive modes of transportation, which currently contribute to a significant portion of greenhouse gas emissions, to active and collective modes of transport would not only improve global planetary health but also individual health (Boniface et al., 2015; Giles-corti et al., 2022; Zhang et al., 2022). High levels of air pollution and poor air quality, which are more prevalent in socioeconomically disadvantaged areas, are strongly associated with respiratory, cardiovascular, cancer, metabolic diseases, and premature mortality (Thurston et al., 2017). Similarly, an increase in active mobility can lead to higher levels of physical activity during travel, resulting in improved lipid profiles and anthropometric measures (Boniface et al., 2015; Giles-corti et al., 2022; Zhang et al., 2022). Although active mobility represents a small proportion of total physical activity (Strain et al., 2020), it can yield substantial benefits, particularly for lower social classes where higher levels of physical inactivity are observed (Moreno-Llamas et al., 2020). Therefore, active mobility policies targeted specifically at low socioeconomic groups and neighborhoods can contribute to addressing issues of physical inactivity, climate crisis, and health inequalities in Europe. Such policies would improve air quality and overall well-being across the population.

Future research should delve deeper into the relationship between socioeconomic status, size of the environment, and active mobility by integrating both objective and self-reported measures. Self-reporting should cover aspects related to environmental awareness, social norms, individual norms, environmental attitudes, intentions, and perceptions of the environment, alongside measures of socioeconomic status and the built environment. Additionally, objective measures of actual mobility behaviors, such as walking or cycling between destinations, and the availability and accessibility of active mobility and public transport infrastructures should be included, as well as other factors, such as car ownership and the presence of alternative vehicles like bicycles.

6. Conclusions

In conclusion, pro-environmental policies should prioritize addressing and reducing social and economic inequalities while promoting pro-environmental awareness. This will contribute to fostering a more sustainable approach to active mobility, encompassing walking, cycling, and the use of public transport. Public policies aimed at reducing socioeconomic inequalities can facilitate the translation of pro-environmental mobility awareness into tangible alternatives to private car use, creating healthier, more active, and sustainable environments. These efforts will not only mitigate air pollution but also promote increased physical activity and improved population health.

CRediT authorship contribution statement

AML contributed to perform the study and data analysis. JGM contributed to perform the study. EDCS participated in the design of the study and contributed to perform the study and data analysis. All authors contributed to the manuscript writing. All authors have read and approved the final version of the manuscript and agree with the order of the presentation of the authors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

De-identified data from this study are available in a protected archive: doi:https://doi.org/10.4232/1.13652. The download of datasets generally requires a login at GESIS. Registration at GESIS is free of charge, open to all and gives you access to various GESIS services.

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Ethical approval and informed consent

This study was exempt from the approval by an appropriately constituted committee for human subjects and informed consent from participants as it was an analysis of secondary data collected by the GESIS Leibniz Institute for the Social Sciences.

Code availability

The analytic code used to conduct the analyses presented in this study are available in a public archive: https://github.com/antoniomoreno13/A-social-gradient-on-pro-environmental-active-mobility-across-Europe.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cities.2023.104716.

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Supplemental Material for:

Social inequalities hamper pro-environmental mobility intentions in Europe

This file includes:

Definition of Indices of fit of Structural Equation Models

Results of Indices of fit of Structural Equation Models

Unadjusted results of Structural Equation Models

Tables S1 to S5

Figures S1 to S8

Supplementary references

Definition of Indices of fit of Structural Equation Models

According to (Fan et al., 1999):

- The Chi-square statistic assesses overall fit and the discrepancy between the sample and fitted covariance matrices. A *p*-value greater than 0.05 indicates that the hypothesis of a perfect fit cannot be rejected. However, it is sensitive to sample size.
- The Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) represent the proportion of variance accounted for by the estimated population covariance. The GFI and AGFI should be greater than 0.95 and 0.90, respectively.
- The Normed Fit Index (NFI) and Non-Normed Fit Index (NNFI) measure the fit of the model. Both indices should be greater than 0.90.
- The Comparative Fit Index (CFI) is a revised form of the NFI and is less sensitive to sample size. It compares the fit of a target model to that of an independent or null model. The CFI should be greater than 0.90.
- The Root Mean Square Error of Approximation (RMSEA) is a parsimony-adjusted index. The RMSEA should be less than or 0.05. The *p*-value associated with the RMSEA tests the hypothesis that it is less than or equal to 0.05, which is considered a cutoff for good fit.
- The Standardized Root Mean Square Residual (SRMR) represents the square root of the difference between the residuals of the sample covariance matrix and the hypothesized model. The SRMR should be less than 0.08.
- The Relative Fit Index (RFI) does not have a guaranteed range from 0 to 1. However, an RFI close to 1 indicates a good fit. The RFI should be greater than 0.90.
- The Parsimony-Adjusted Measures Index (PNFI) does not have a commonly agreed-upon cutoff value for an acceptable model. It should be greater than 0.50.
- The Incremental Fit Index (IFI) adjusts the Normed Fit Index (NFI) for sample size and degrees of freedom. A value over 0.90 indicates a good fit, but the index can exceed 1.

Results of Indices of fit of Structural Equation Models

The results of the different fit indices for adjusted and unadjusted structural equation models of pro-environmental intentions are described in Table S1. Generally, the three types of models (based on the dependent variables of choosing a more environmental way of traveling, using the car less, and willingness to share personal information to improve public transport) showed similar validation results. However, there were notable differences between the adjusted and unadjusted models. Among the 11 fit indices, the age- and gender-adjusted structural equation models reported only one index (SRMR, Standardized Root Mean Square Residual) as satisfactory. Conversely, when the analyses were performed without controlling for age and gender, the model fitness improved, with 7 out of 11 indices being deemed satisfactory (GFI, AGFI, NFI, CFI, RMSEA, SRMR, and IFI).

Regarding sensitivity analysis using dummy variables (Table S2), both the adjusted and unadjusted structural equation models for gender and age (continuous) in relation to choosing a more environmental way of traveling, using the car less, and willingness to share personal information to improve public transport generally showed most satisfactory indices regardless of the outcome variable. The adjusted models had 6 out of 11 satisfactory indices, while the unadjusted models had 7 out of 11 satisfactory indices. The poor-quality indices in both approaches were the chi-square, NNFI, RFI, PNFI, and AGFI (adjusted models only).

Unadjusted results of Structural Equation Models

Despite the significant variations in fit indices between the adjusted and unadjusted structural equation models, the coefficient estimates remained unchanged in terms of statistical significance and direction when age and gender were not controlled (Fig. S1). The association between the size of the community and environmental awareness and pro-environmental intentions did not differ in terms of direct or indirect effects. In contrast, the relationships between socioeconomic status, environmental awareness, and pro-environmental intentions were attenuated in both direct and indirect effects. Additionally, the direct effect of socioeconomic status on environmental intentions was moderate in the age- and gender-adjusted estimates for choosing a more environmental way of traveling ($\beta = 0.363$, $P < 0.001$) and using the car less ($\beta = 0.365$, $P < 0.001$) compared to the unadjusted models ($\beta = 0.264$, $P < 0.001$ and $\beta = 0.257$, $P < 0.001$, respectively). Furthermore, the strength of the association between environmental awareness and pro-environmental intentions also decreased.

Table S1
Indices of fit of main analyses of the different adjusted[a] and unadjusted structural equation models for the three pro-environmental intentions, European Union 2019

		Environmentally way of travelling				Have used your car less				Willing to improve public transport			
		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted	
	Threshold	Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation
Chi-square	0.05	0.0000	Poor	0.0000	Poor	0.0000	Poor	0.0000	Poor	0.0000	Poor	0.0000	Poor
GFI	0.95	0.9477	Poor	**0.9914**	**Satisfactory**	0.9488	Poor	**0.9923**	**Satisfactory**	0.9488	Poor	**0.9916**	**Satisfactory**
AGFI	0.90	0.8894	Poor	**0.9778**	**Satisfactory**	0.8917	Poor	**0.9803**	**Satisfactory**	0.8918	Poor	**0.9785**	**Satisfactory**
NFI	0.90	0.7082	Poor	**0.9416**	**Satisfactory**	0.7074	Poor	**0.9464**	**Satisfactory**	0.7102	Poor	**0.9423**	**Satisfactory**
NNFI	0.90	0.5072	Poor	0.8848	Poor	0.5059	Poor	0.8945	Poor	0.5107	Poor	0.8864	Poor
CFI	0.90	0.7089	Poor	**0.9424**	**Satisfactory**	0.7081	Poor	**0.9472**	**Satisfactory**	0.7109	Poor	**0.9432**	**Satisfactory**
RMSEA	0.05	0.0950	Poor	**0.0495**	**Satisfactory**	0.0942	Poor	**0.0467**	**Satisfactory**	0.0943	Poor	**0.0488**	**Satisfactory**
SRMR	0.08	**0.0614**	**Satisfactory**	**0.0299**	**Satisfactory**	**0.0609**	**Satisfactory**	**0.0287**	**Satisfactory**	**0.0612**	**Satisfactory**	**0.0296**	**Satisfactory**
RFI	0.90	0.5062	Poor	0.8832	Poor	0.5048	Poor	0.8927	Poor	0.5096	Poor	0.8846	Poor
PNFI	0.50	0.4185	Poor	0.4708	Poor	0.4180	Poor	0.4732	Poor	0.4197	Poor	0.4712	Poor
IFI	0.90	0.7091	Poor	**0.9425**	**Satisfactory**	0.7083	Poor	**0.9473**	**Satisfactory**	0.7111	Poor	**0.9432**	**Satisfactory**

[a] Adjusted structural equation models were controlled for age (continuous) and gender.
Notes: GFI, Goodness of Fit; AGFI, Adjusted Goodness of Fit; NFI, Normed Fit Index; NNFI, Non Normed Fit Index; CFI, Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; RFI, Relative Fit Index; PNFI, Parsimony-Adjusted Measures Index; IFI, Incremental Fit Index.

Table S2
Indices of fit of sensitivity analyses the different adjusted[a] and unadjusted structural equation models for the three pro-environmental intentions, European Union 2019

		Environmentally way of travelling				Have used your car less				Willing to improve public transport			
		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted	
	Threshold	Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation
Chi-square	0.05	0.0000	Poor	0.0000	Poor	0.0000	Poor	0.0000	Poor	0.0000	Poor	0.0000	Poor
GFI	0.95	**0.9804**	**Satisfactory**	**0.9830**	**Satisfactory**	**0.9806**	**Satisfactory**	**0.9832**	**Satisfactory**	**0.9807**	**Satisfactory**	**0.9834**	**Satisfactory**
AGFI	0.90	0.8975	Poor	**0.9185**	**Satisfactory**	0.8988	Poor	**0.9197**	**Satisfactory**	0.8993	Poor	**0.9204**	**Satisfactory**
NFI	0.90	**0.9021**	**Satisfactory**	**0.9126**	**Satisfactory**	**0.9001**	**Satisfactory**	**0.9106**	**Satisfactory**	**0.9023**	**Satisfactory**	**0.9123**	**Satisfactory**
NNFI	0.90	0.7911	Poor	0.8103	Poor	0.7867	Poor	0.8060	Poor	0.7915	Poor	0.8096	Poor
CFI	0.90	**0.9039**	**Satisfactory**	**0.9142**	**Satisfactory**	**0.9019**	**Satisfactory**	**0.9122**	**Satisfactory**	**0.9041**	**Satisfactory**	**0.9139**	**Satisfactory**
RMSEA	0.05	**0.0415**	**Satisfactory**	**0.0423**	**Satisfactory**	**0.0413**	**Satisfactory**	**0.0421**	**Satisfactory**	**0.0411**	**Satisfactory**	**0.0419**	**Satisfactory**
SRMR	0.08	**0.0197**	**Satisfactory**	**0.0218**	**Satisfactory**	**0.0196**	**Satisfactory**	**0.0217**	**Satisfactory**	**0.0194**	**Satisfactory**	**0.0215**	**Satisfactory**
RFI	0.90	0.7873	Poor	0.8068	Poor	0.7827	Poor	0.8024	Poor	0.7876	Poor	0.8060	Poor
PNFI	0.50	0.4150	Poor	0.4129	Poor	0.4140	Poor	0.4119	Poor	0.4150	Poor	0.4127	Poor
IFI	0.90	**0.9042**	**Satisfactory**	**0.9144**	**Satisfactory**	**0.9022**	**Satisfactory**	**0.9124**	**Satisfactory**	**0.9044**	**Satisfactory**	**0.9141**	**Satisfactory**

[a] Adjusted structural equation models were controlled for age (continuous) and gender.
Notes: GFI, Goodness of Fit; AGFI, Adjusted Goodness of Fit; NFI, Normed Fit Index; NNFI, Non Normed Fit Index; CFI, Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; RFI, Relative Fit Index; PNFI, Parsimony-Adjusted Measures Index; IFI, Incremental Fit Index.

Table S3

Results of sensitivity analyses of the adjusted and unadjusted structural equation modelling on environmental way of travelling, European Union 2019

	Adjustment[a]	Total effect (95%CI)	P-value	Direct effect (95%CI)	P-value	Indirect effect (95%CI)	P-value	Effect on mediator (95%CI)	P-value
Educational level (ref: up to 15 years)									
16 to 19 years	Unadjusted	0.032 (0.016, 0.048)	< 0.001	0.035 (0.019, 0.051)	< 0.001	-0.003 (-0.006, 0.001)	0.135	-0.019 (-0.043, 0.005)	0.133
	Adjusted	0.040 (0.023, 0.055)	< 0.001	0.041 (0.024, 0.056)	< 0.001	-0.001 (-0.004, 0.003)	0.704	-0.004 (-0.026, 0.017)	0.704
20 years and older	Unadjusted	0.113 (0.095, 0.132)	< 0.001	0.106 (0.088, 0.126)	< 0.001	0.007 (0.003, 0.010)	< 0.001	0.050 (0.023, 0.076)	< 0.001
	Adjusted	0.121 (0.103, 0.139)	< 0.001	0.113 (0.095, 0.130)	< 0.001	0.008 (0.005, 0.012)	< 0.001	0.052 (0.028, 0.075)	< 0.001
Still studying	Unadjusted	0.191 (0.161, 0.221)	< 0.001	0.186 (0.157, 0.216)	< 0.001	0.005 (0.000, 0.010)	0.048	0.038 (0.002, 0.076)	0.047
	Adjusted	0.218 (0.148, 0.252)	< 0.001	0.207 (0.174, 0.241)	< 0.001	0.011 (0.005, 0.017)	< 0.001	0.069 (0.030, 0.104)	< 0.001
Subjective social class (ref: low social class)									
Middle social class	Unadjusted	0.023 (0.011, 0.035)	< 0.001	0.020 (0.008, 0.032)	0.001	0.003 (0.001, 0.006)	0.011	0.023 (0.006, 0.040)	0.009
	Adjusted	0.023 (0.011, 0.035)	< 0.001	0.020 (0.009, 0.032)	0.001	0.003 (0.001, 0.005)	0.011	0.018 (0.004, 0.031)	0.010
High social class	Unadjusted	0.088 (0.063, 0.113)	< 0.001	0.086 (0.061, 0.111)	< 0.001	0.002 (-0.002, 0.006)	0.357	0.015 (-0.015, 0.046)	0.356
	Adjusted	0.089 (0.064, 0.116)	< 0.001	0.086 (0.062, 0.112)	< 0.001	0.003 (-0.001, 0.007)	0.166	0.017 (-0.008, 0.041)	0.164
Economic issues (ref: most of the time)									
From time to time	Unadjusted	0.006 (-0.016, 0.027)	0.601	0.007 (-0.015, 0.028)	0.516	-0.001 (-0.007, 0.004)	0.556	-0.011 (-0.050, 0.026)	0.555
	Adjusted	0.006 (-0.015, 0.028)	0.595	0.007 (-0.015, 0.030)	0.524	-0.001 (-0.006, 0.003)	0.635	-0.007 (-0.036, 0.021)	0.634
Almost never or never	Unadjusted	0.040 (0.019, 0.061)	< 0.001	0.035 (0.015, 0.056)	0.001	0.005 (0.000, 0.009)	0.041	0.035 (0.000, 0.068)	0.040
	Adjusted	0.037 (0.017, 0.059)	< 0.001	0.033 (0.012, 0.055)	0.002	0.004 (-0.000, 0.009)	0.056	0.027 (-0.000, 0.055)	0.056
Size of the community (ref: rural area)									
Small urban area	Unadjusted	0.039 (0.026, 0.054)	< 0.001	0.034 (0.015, 0.056)	< 0.001	0.006 (0.003, 0.009)	< 0.001	0.043 (0.024, 0.063)	< 0.001
	Adjusted	0.039 (0.026, 0.053)	< 0.001	0.034 (0.020, 0.048)	< 0.001	0.006 (0.003, 0.009)	< 0.001	0.035 (0.019, 0.051)	< 0.001
Large urban area	Unadjusted	0.085 (0.071, 0.099)	< 0.001	0.075 (0.061, 0.089)	< 0.001	0.010 (0.007, 0.013)	< 0.001	0.075 (0.057, 0.094)	< 0.001
	Adjusted	0.085 (0.071, 0.099)	< 0.001	0.076 (0.061, 0.089)	< 0.001	0.010 (0.007, 0.013)	< 0.001	0.061 (0.044, 0.077)	< 0.001
Pro-environmental awareness									
Latent variable	Unadjusted			0.134 (0.119, 0.150)	< 0.001				
	Adjusted			0.163 (0.146, 0.181)	< 0.001				

[a] Structural equation models were adjusted by age (continuous) and gender

Table S4
Results of sensitivity analyses of the adjusted and unadjusted structural equation modelling on having used your car less, European Union 2019

	Adjustment[a]	Total effect (95%CI)	P-value	Direct effect (95%CI)	P-value	Indirect effect (95%CI)	P-value	Effect on mediator (95%CI)	P-value
Educational level (ref: up to 15 years)									
16 to 19 years	Unadjusted	0.025 (0.011, 0.039)	< 0.001	0.027 (0.013, 0.041)	< 0.001	-0.002 (-0.004, 0.000)	0.149	-0.018 (-0.043, 0.005)	0.145
	Adjusted	0.031 (0.017, 0.046)	< 0.001	0.032 (0.017, 0.047)	< 0.001	-0.000 (-0.003, 0.002)	0.676	-0.004 (-0.024, 0.017)	0.676
20 years and older	Unadjusted	0.093 (0.077, 0.109)	< 0.001	0.089 (0.073, 0.106)	< 0.001	0.004 (0.002, 0.007)	0.001	0.047 (0.020, 0.072)	< 0.001
	Adjusted	0.100 (0.084, 0.116)	< 0.001	0.094 (0.078, 0.110)	< 0.001	0.006 (0.003, 0.008)	< 0.001	0.052 (0.029, 0.076)	< 0.001
Still studying	Unadjusted	0.023 (0.000, 0.048)	0.056	0.020 (-0.004, 0.044)	0.100	0.003 (-0.000, 0.007)	0.058	0.037 (-0.000, 0.074)	0.054
	Adjusted	0.043 (0.014, 0.070)	0.002	0.036 (0.007, 0.062)	0.009	0.008 (0.003, 0.012)	< 0.001	0.070 (0.032, 0.107)	< 0.001
Subjective social class (ref: low social class)									
Middle social class	Unadjusted	0.033 (0.022, 0.045)	< 0.001	0.031 (0.021, 0.041)	< 0.001	0.002 (0.000, 0.003)	0.009	0.022 (0.005, 0.037)	0.008
	Adjusted	0.034 (0.022, 0.045)	< 0.001	0.032 (0.020, 0.043)	< 0.001	0.002 (0.000, 0.004)	0.012	0.018 (0.003, 0.032)	0.010
High social class	Unadjusted	0.100 (0.076, 0.122)	< 0.001	0.099 (0.075, 0.121)	< 0.001	0.001 (-0.001, 0.004)	0.390	0.013 (-0.017, 0.044)	0.389
	Adjusted	0.099 (0.075, 0.123)	< 0.001	0.097 (0.074, 0.121)	< 0.001	0.002 (-0.001, 0.005)	0.191	0.017 (-0.009, 0.040)	0.185
Economic issues (ref: most of the time)									
From time to time	Unadjusted	0.007 (-0.013, 0.024)	0.470	0.007 (-0.011, 0.025)	0.416	-0.001 (-0.004, 0.002)	0.590	-0.009 (-0.041, 0.027)	0.588
	Adjusted	0.006 (-0.014, 0.024)	0.494	0.007 (-0.013, 0.025)	0.453	-0.001 (-0.004, 0.003)	0.677	-0.006 (-0.033, 0.023)	0.675
Almost never or never	Unadjusted	0.044 (0.026, 0.061)	< 0.001	0.041 (0.023, 0.058)	< 0.001	0.003 (0.000, 0.006)	0.047	0.033 (0.002, 0.066)	0.043
	Adjusted	0.041 (0.022, 0.058)	< 0.001	0.038 (0.019, 0.055)	< 0.001	0.003 (-0.000, 0.006)	0.064	0.027 (-0.001, 0.054)	0.061
Size of the community (ref: rural area)									
Small urban area	Unadjusted	0.032 (0.019, 0.045)	< 0.001	0.028 (0.015, 0.041)	< 0.001	0.004 (0.002, 0.006)	< 0.001	0.042 (0.023, 0.062)	< 0.001
	Adjusted	0.032 (0.020, 0.044)	< 0.001	0.028 (0.016, 0.040)	< 0.001	0.004 (0.002, 0.006)	< 0.001	0.036 (0.020, 0.052)	< 0.001
Large urban area	Unadjusted	0.040 (0.029, 0.052)	< 0.001	0.034 (0.023, 0.045)	< 0.001	0.007 (0.005, 0.009)	< 0.001	0.072 (0.054, 0.091)	< 0.001
	Adjusted	0.041 (0.029, 0.052)	< 0.001	0.034 (0.022, 0.046)	< 0.001	0.007 (0.005, 0.009)	< 0.001	0.062 (0.046, 0.076)	< 0.001
Pro-environmental awareness									
Latent variable	Unadjusted			0.092 (0.078, 0.104)	< 0.001				
	Adjusted			0.110 (0.095, 0.125)	< 0.001				

[a] Structural equation models were adjusted by age (continuous) and gender

Table S5
Results of sensitivity analyses of the adjusted and unadjusted structural equation modelling on willing to improve public transport, European Union 2019

	Adjustment[a]	Total effect (95%CI)	P-value	Direct effect (95%CI)	P-value	Indirect effect (95%CI)	P-value	Effect on mediator (95%CI)	P-value
Educational level (ref: up to 15 years)									
16 to 19 years	Unadjusted	0.031 (0.018, 0.047)	< 0.001	0.034 (0.018, 0.050)	< 0.001	-0.002 (-0.006, 0.001)	0.146	-0.019 (-0.045, 0.006)	0.139
	Adjusted	0.013 (-0.004, 0.029)	0.101	0.014 (-0.002, 0.030)	0.086	-0.001 (-0.004, 0.003)	0.676	-0.004 (-0.025, 0.016)	0.677
20 years and older	Unadjusted	0.091 (0.073, 0.109)	< 0.001	0.085 (0.066, 0.103)	< 0.001	0.006 (0.003, 0.010)	0.001	0.048 (0.020, 0.076)	0.001
	Adjusted	0.071 (0.053, 0.089)	< 0.001	0.063 (0.044, 0.080)	< 0.001	0.009 (0.005, 0.012)	< 0.001	0.051 (0.029, 0.073)	< 0.001
Still studying	Unadjusted	0.162 (0.131, 0.192)	< 0.001	0.157 (0.127, 0.187)	< 0.001	0.005 (0.000, 0.010)	0.046	0.038 (-0.002, 0.074)	0.043
	Adjusted	0.100 (0.066, 0.133)	< 0.001	0.089 (0.054, 0.119)	< 0.001	0.011 (0.005, 0.017)	< 0.001	0.068 (0.031, 0.102)	< 0.001
Subjective social class (ref: low social class)									
Middle social class	Unadjusted	0.045 (0.033, 0.057)	< 0.001	0.042 (0.030, 0.054)	< 0.001	0.003 (0.001, 0.005)	0.008	0.022 (0.007, 0.039)	0.006
	Adjusted	0.044 (0.032, 0.056)	< 0.001	0.041 (0.029, 0.053)	< 0.001	0.003 (0.000, 0.005)	0.017	0.017 (0.003, 0.032)	0.016
High social class	Unadjusted	0.109 (0.083, 0.130)	< 0.001	0.107 (0.082, 0.128)	< 0.001	0.002 (-0.002, 0.006)	0.397	0.013 (-0.018, 0.045)	0.393
	Adjusted	0.107 (0.083, 0.131)	< 0.001	0.104 (0.080, 0.127)	< 0.001	0.003 (-0.001, 0.007)	0.213	0.016 (-0.008, 0.042)	0.212
Economic issues (ref: most of the time)									
From time to time	Unadjusted	0.009 (-0.013, 0.032)	0.426	0.010 (-0.011, 0.033)	0.364	-0.001 (-0.006, 0.003)	0.590	-0.010 (-0.043, 0.025)	0.588
	Adjusted	0.009 (-0.014, 0.031)	0.462	0.010 (-0.013, 0.034)	0.410	-0.001 (-0.006, 0.004)	0.670	-0.006 (-0.037, 0.021)	0.670
Almost never or never	Unadjusted	-0.009 (-0.029, 0.012)	0.383	-0.014 (-0.033, 0.008)	0.196	0.004 (0.000, 0.009)	0.052	0.033 (0.002, 0.069)	0.049
	Adjusted	-0.002 (-0.024, 0.019)	0.860	-0.006 (-0.028, 0.015)	0.559	0.004 (-0.000, 0.009)	0.058	0.026 (-0.001, 0.054)	0.059
Size of the community (ref: rural area)									
Small urban area	Unadjusted	0.026 (0.012, 0.039)	< 0.001	0.020 (0.007, 0.034)	0.004	0.006 (0.003, 0.008)	< 0.001	0.043 (0.023, 0.063)	< 0.001
	Adjusted	0.026 (0.013, 0.040)	< 0.001	0.020 (0.007, 0.035)	0.003	0.006 (0.003, 0.008)	< 0.001	0.035 (0.019, 0.051)	< 0.001
Large urban area	Unadjusted	0.068 (0.054, 0.081)	< 0.001	0.059 (0.044, 0.071)	< 0.001	0.010 (0.007, 0.012)	< 0.001	0.074 (0.055, 0.093)	< 0.001
	Adjusted	0.067 (0.053, 0.081)	< 0.001	0.057 (0.043, 0.071)	< 0.001	0.010 (0.008, 0.013)	< 0.001	0.060 (0.045, 0.076)	< 0.001
Pro-environmental awareness									
Latent variable	Unadjusted			0.131 (0.118, 0.145)	< 0.001				
	Adjusted			0.168 (0.152, 0.184)	< 0.001				

[a] Structural equation models were adjusted by age (continuous) and gender

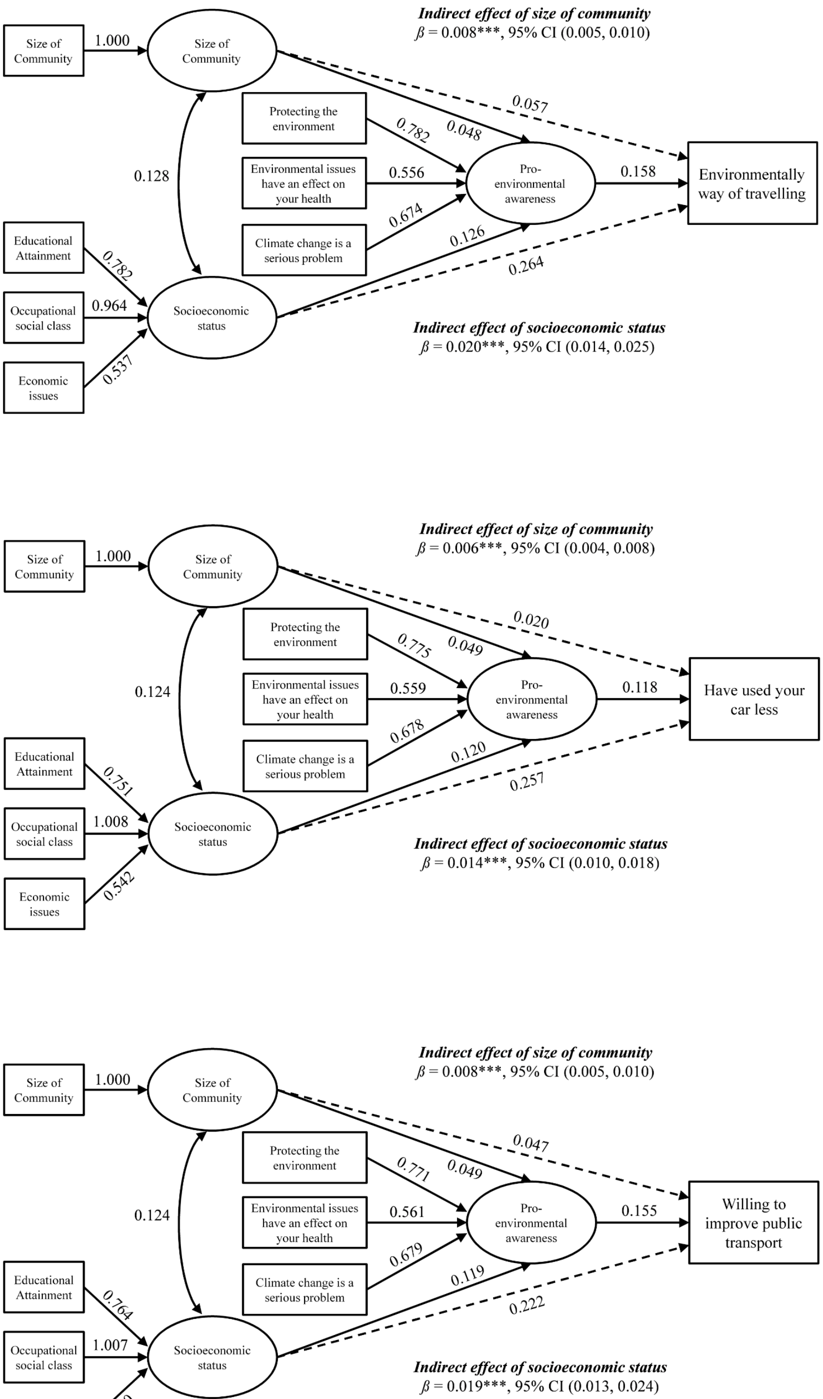

Fig. S1. Pro-environmental awareness mediates in the association between socioeconomic status and size of community with pro-environmental intentions. Unadjusted standardized beta coefficients and factor loadings of latent variables are presented in the structural equation modelling analyses. All coefficients were highly statistically significant ($P < 0.001$). * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

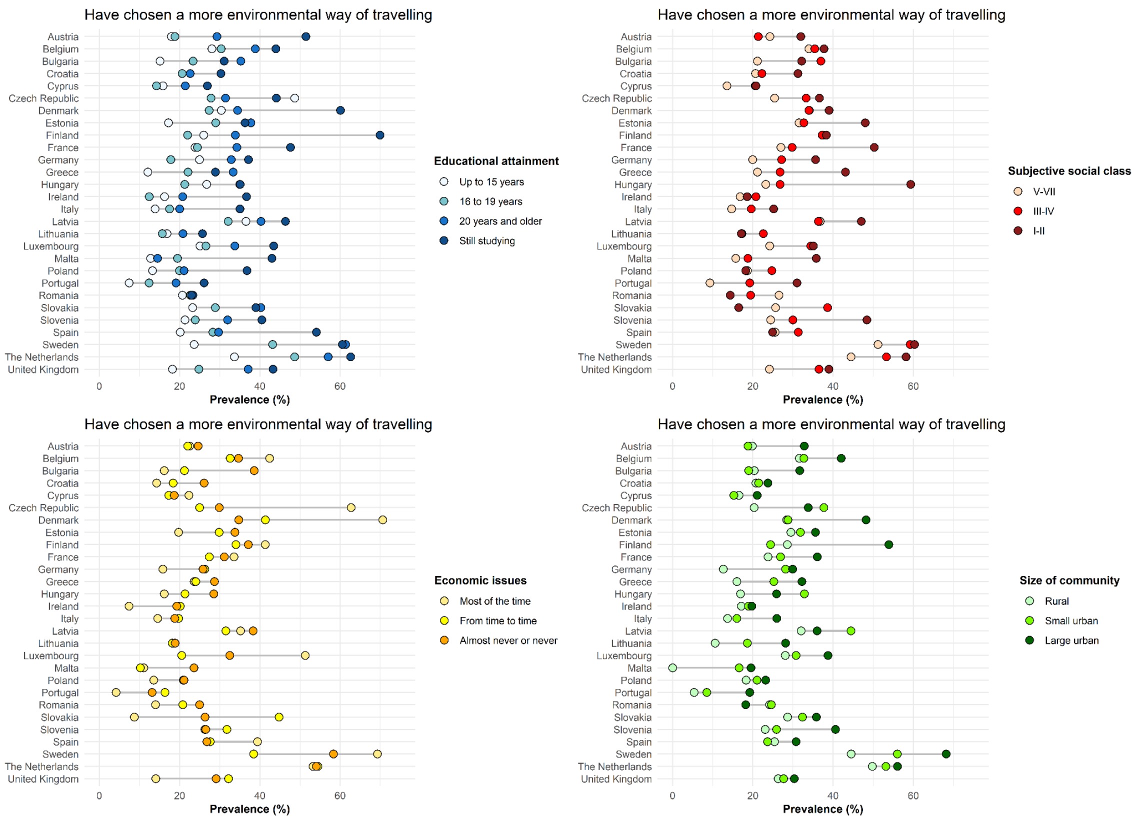

Fig. S2. Social gradient of choosing a more environmental way of travelling across EU-28. Prevalence of the pro-environmental intention is presented by educational attainment, subjective social class, economic issues, and size of community.

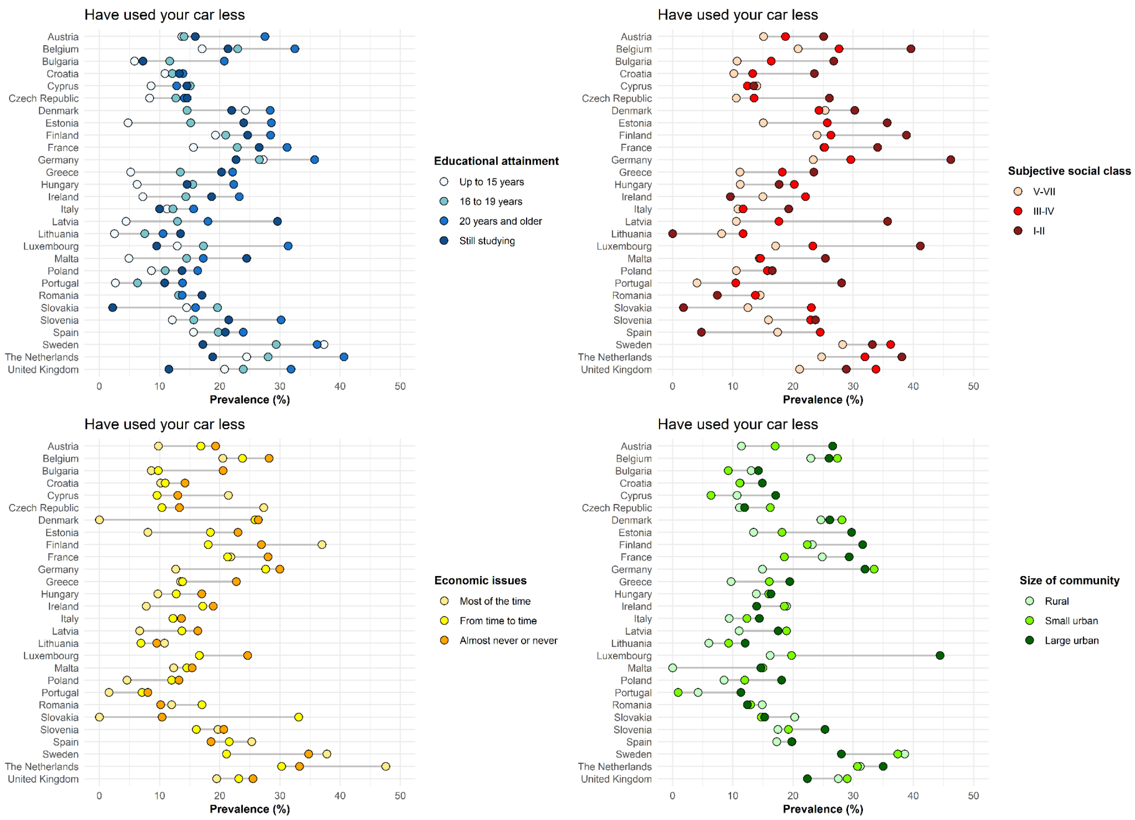

Fig. S3. Social gradient of having used less the car across EU-28. Prevalence of the pro-environmental intention is presented by educational attainment, subjective social class, economic issues, and size of community.

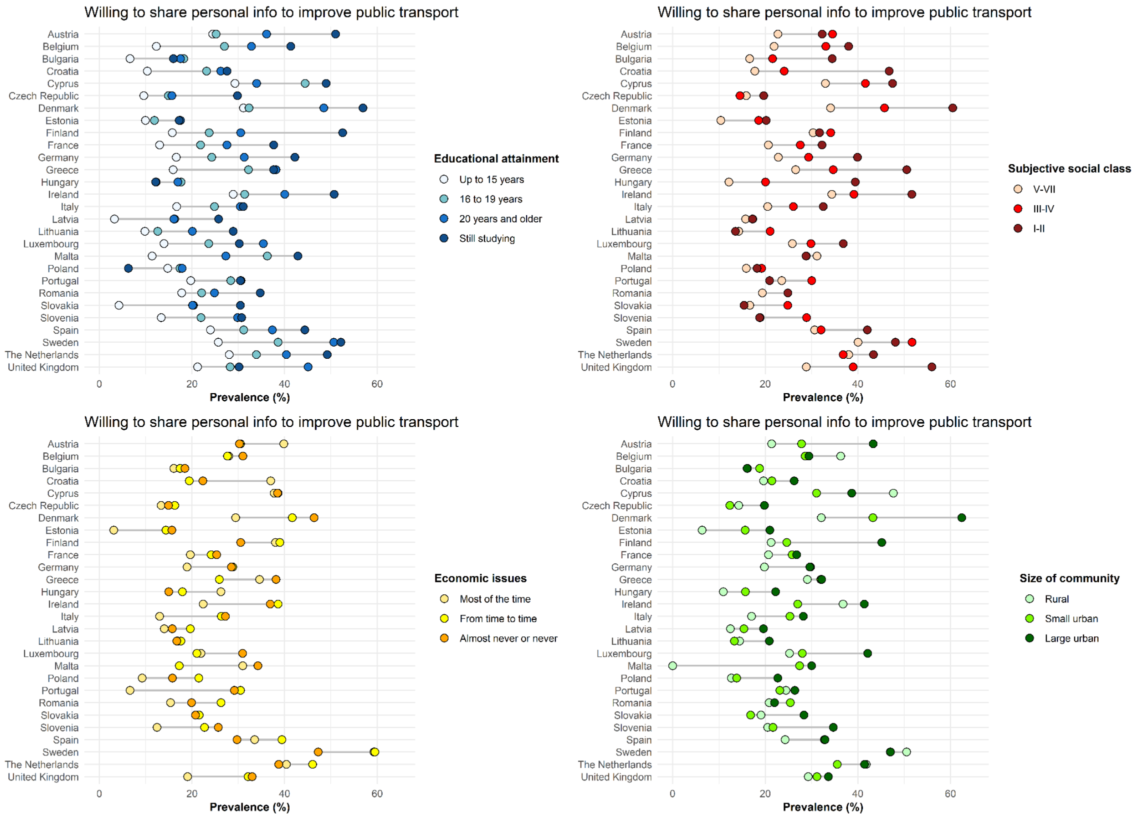

Fig. S4. Social gradient of willing to share personal information to improve public transport across EU-28. Prevalence of the pro-environmental intention is presented by educational attainment, subjective social class, economic issues, and size of community.

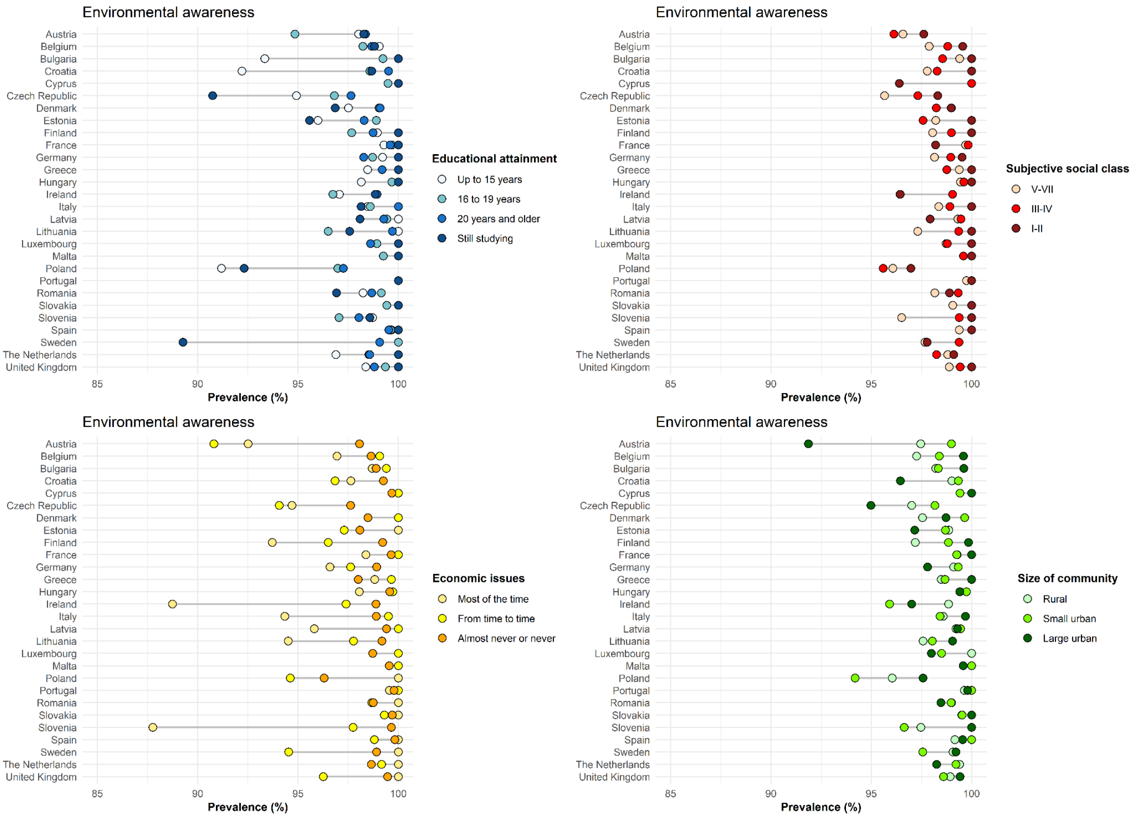

Fig. S5. Social gradient of pro-environmental awareness across EU-28. Prevalence of the pro-environmental awareness is presented by educational attainment, subjective social class, economic issues, and size of community.

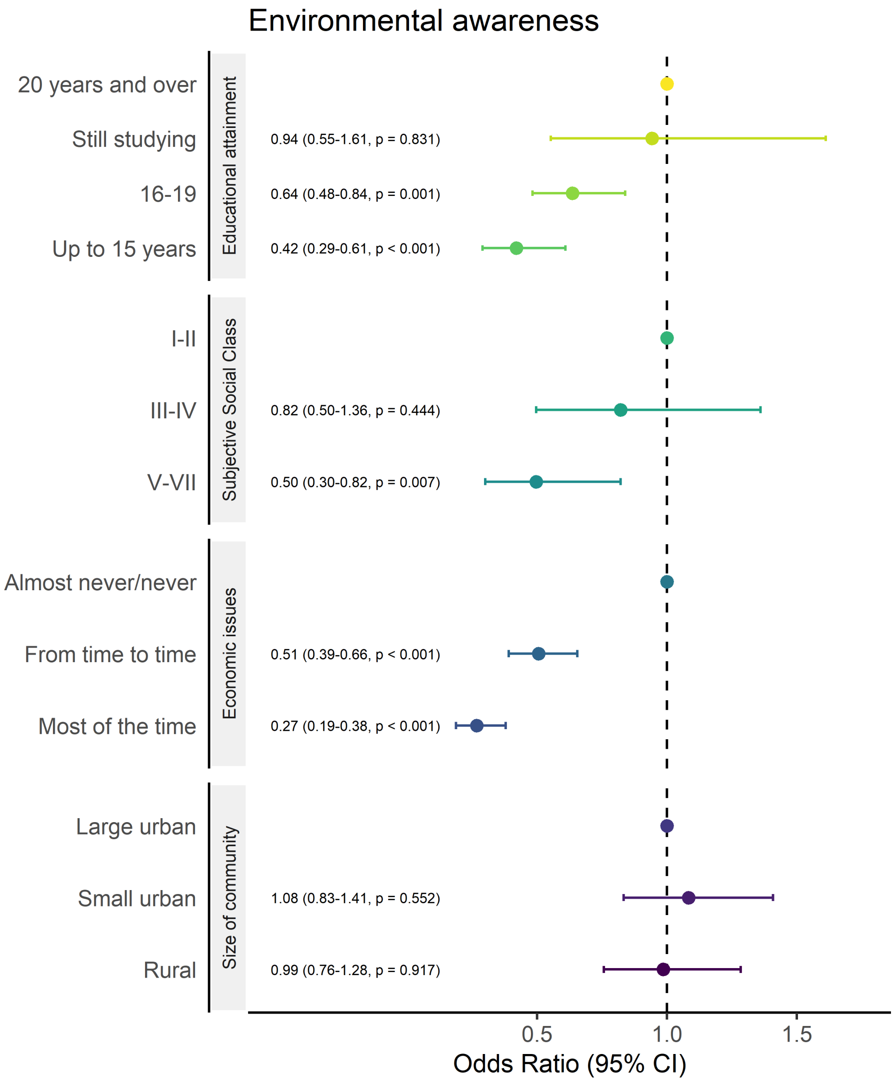

Fig. S6. Social determinants are gradually associated with a pro-environmental awareness across EU-28. Odds ratio (95% CI) are presented by educational attainment, subjective social class, economic issues, and size of community. European Union-28, 2019.

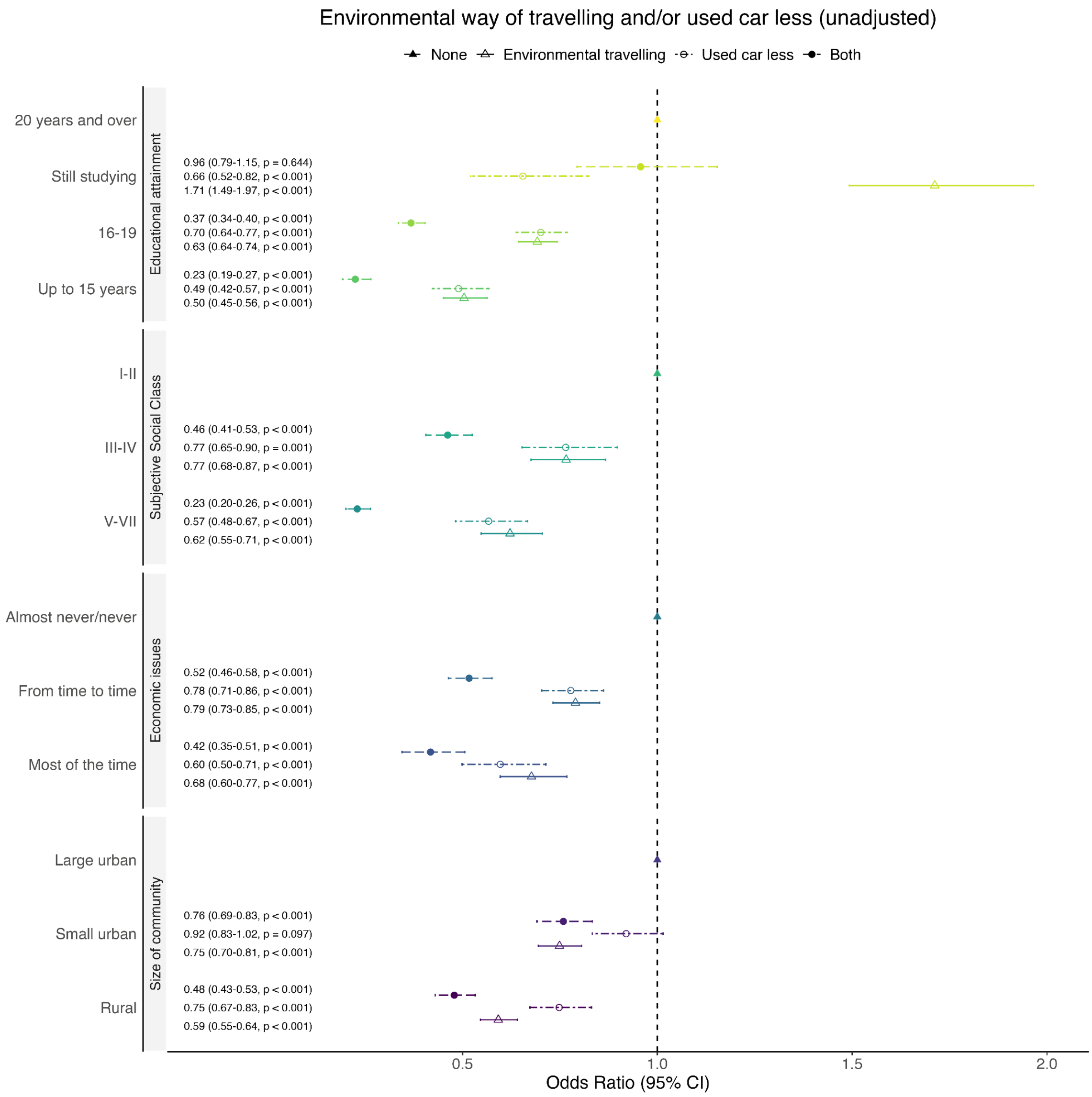

Fig. S7. Social determinants are associated with having chosen a more environmental-friendly way of travelling in the past six months and/or using car less unadjusted for pro-environmental awareness across EU-28. Odds ratio (95% CI) are presented by educational attainment, subjective social class, economic issues, and size of community. European Union-28, 2019.

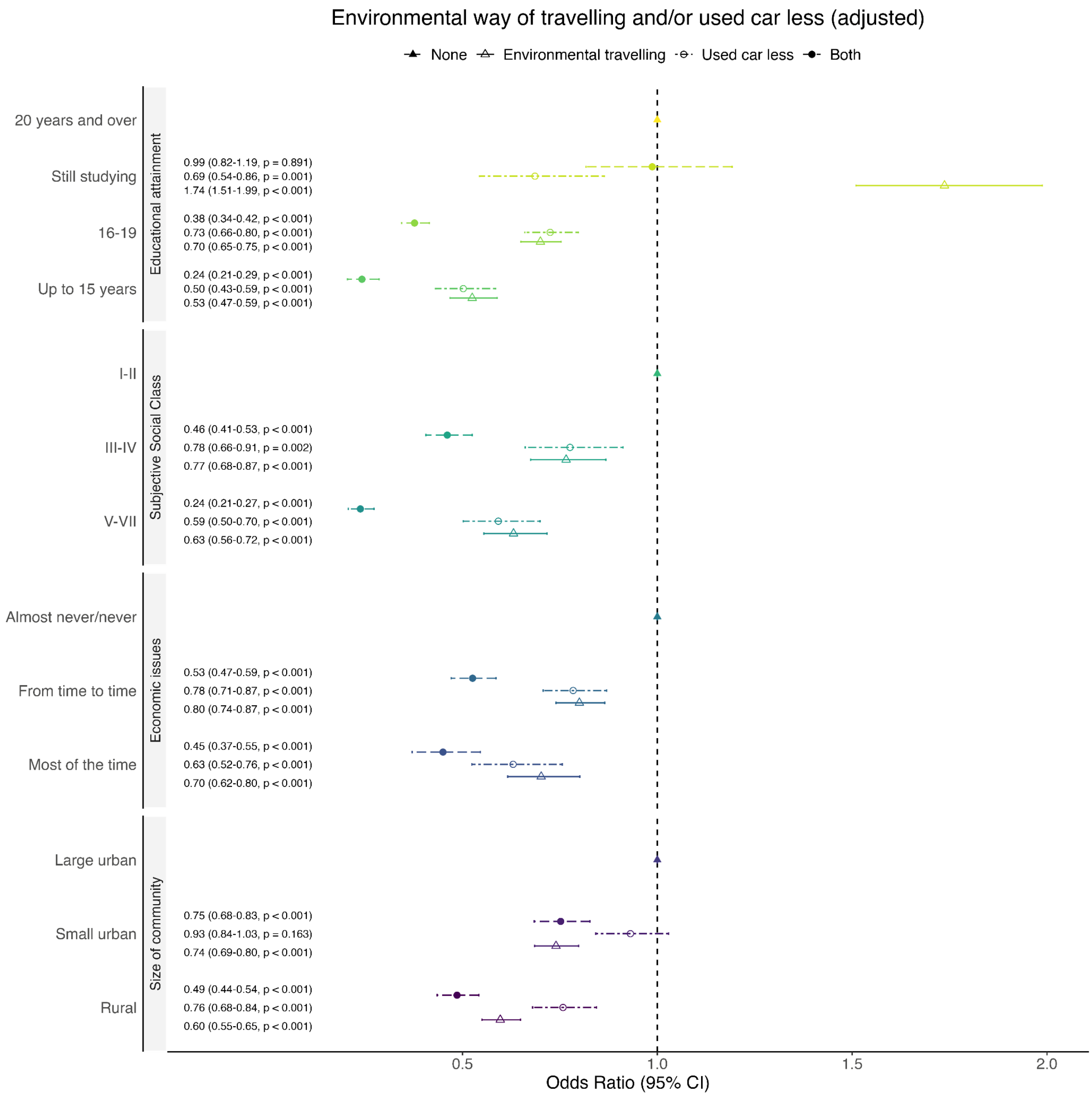

Fig. S8. Social determinants are associated with having chosen a more environmental-friendly way of travelling in the past six months and/or using car less adjusted for pro-environmental awareness across EU-28. Odds ratio (95% CI) are presented by educational attainment, subjective social class, economic issues, and size of community. European Union-28, 2019.

Supplementary references

Fan, X., Thompson, B., & Wang, L. (1999). Effects of sample size, estimation methods, and model specification on structural equation modeling fit indexes. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 56–83. https://doi.org/10.1080/10705519909540119