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Living and Walking in Cities

New challenges for sustainable urban mobility

This Special Issue intended to wonder about the new challenges for sustainable urban mobility, aligning with the European Sustainable & Smart Mobility Strategy. Contributions come from selected papers of the XXVI International Conference "Living and Walking in Cities" and have been collected around two main topics: the relationship between transport systems and pedestrian mobility and the transformative potential of temporary urban changes. Reflections and suggestions elaborated underline a collective great leap forward to reshaping urban mobility paradigms.

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Living and walking in cities: new challenges for sustainable urban mobility

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Cover photo: Herrengasse street in Graz (Austria), baroque pedestrian avenue and centre of public life, provided by Michela Tiboni (June, 2024)

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Evaluating active mobility: enhancing the framework for social sustainability

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Abstract
Active mobility plays a crucial role in reducing traffic congestion, improving air quality, promoting well-being, good health, and fostering social equality, all of which align with the concept of social sustainability within the Sustainable Development Goals (SDGs). However, assessing the impact of active mobility on social sustainability remains challenging due to the lack of clear identification of the specific SDGs influenced by it. This review analyses how previous articles quantify active mobility, its antecedents, and impacts. Additionally, it aims to find if any impacts can contribute to defining Social Sustainability. A Rapid Evident Assessment method was employed in this research in two databases: PsycINFO and Scopus. Out of the first pool of 61 papers, 19 articles were selected. The findings provide a comprehensive framework of the variables that influence active mobility and those influenced by it. Active mobility predominantly contributes to addressing the 11th, 10th and 3rd SDGs. Furthermore, the social sustainability quantification can benefit from assessing active mobility impacts. This work also identifies knowledge gaps, offering valuable guidance for future research in the field.

Keywords
Urban planning; Sustainability; Behavioural change; Review.

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1. Introduction

Active Mobility (AM) is a regular physical activity undertaken as a means of transport. It includes walking, cycling, pedal-assisted e-bikes, kick-scooters, skateboards, and other vehicles which require physical effort to get moving, while it does not include physical activities that are undertaken for recreation purposes (EIT Urban Mobility, 2020). There are both individual and public health benefits of active mobility, primarily through the direct impacts of physical activity, but also indirectly through reduced air pollution and noise pollution if AM modes increase due to a shift from non-active modes (e.g., Carra et al., 2023; D'Amico, 2023; Gargiulo & Sgambati, 2022; Tira, 2018). As well as the considerable health benefits, active mobility modes provide benefits in terms of reducing the amount of space used (compared to cars), freeing up space in public transport, reducing CO_2 emissions, and reducing social inequality (Carpentieri et al., 2023; EIT Urban Mobility, 2020; Hwang & Guhathakurta, 2023). Despite the sparse use of the term AM in recent examples of international debate (Pezzagno & Richiedei, 2022), AM can contribute to more sustainable development, in consideration of its definition as "development that meets the needs of the present without compromising the needs of future generations to meet their own needs" (WCED, 1987).

The concept of sustainable development was further systematised into the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015. The Agenda proposes 17 sustainable development goals (SDGs) with 169 targets, whose achievement is quantified by 248 indicators. Considering what was reported above, AM can contribute to reaching the 11th (sustainable cities and communities), 3rd (good health and well-being) and 10th (reduce inequality) SDGs.

The SDGs aim to intervene in three dimensions of sustainable development: the social, economic and environmental. Although these pillars have been deeply investigated, Social Sustainability (SS) remains a fuzzy concept, with no blueprint conceptualisation in policy documents or academic papers (Foladori, 2005).

Social Sustainability has received many definitions, which standalone or interact with environmental sustainability. One of them says that it is "the set of policies, rules and principles laid down in the EU legal order, that aim to reinforce the social dimension of the EU as a long-term solution, ring-fencing it from any relapse into a position of hierarchical subordination to the markets, so that Social Europe can unequivocally be perceived an equal counterpart to the economic constitution" (Alexandris Polomarkakis, 2019). Additionally, it was suggested that the key elements of SS are social progress, improving welfare and living conditions, social cohesion, social policy, urban development, company and organisation performance (McGuine et al., 2020), work conditions, education and social equality (Giovannini, 2018). These elements can fall into the SDGs 11th, 3rd, 4th (quality education), 5th (gender equality), 10th and 8th (decent work and economic growth).

Based on these premises, some of the Social Sustainability objectives could be achieved, or partially fulfilled, by investing in shifting from combustion engine-based transportation to Active Mobility. Thus, this work aims to investigate how the measures of AM can contribute to defining the different aspects of SS.

Therefore, this article will answer to the following research questions: (i) Which variables intervene in enhancing or decreasing AM behaviours, and how were they measured? (ii) How were AM behaviours measured? (iii) Are there any AM impacts that can contribute to reaching the SDGs?

To achieve this goal, a systematic review, performed by the Rapid Evidence Assessment method (Barends et al., 2017), is executed.

This contribution discusses how the active mobility impacts, which were relevant for SDGs, were connected to social sustainability, as well as if it is possible to adopt the AM's affecting variables as parameters for social sustainability assessment.

Moreover, the European community policies encourage providing free access to scientific material. Considering that, it becomes crucial to investigate whether the articles selected for review were open-access and aligned with the primary focus of the publishing journal.

2. Method

A Rapid Evidence Assessment (REA) provides a balanced assessment of what is known (and not known) in the scientific literature about an intervention, problem or practical issue using a systematic methodology to search and critically appraise empirical studies. However, to be 'rapid', an REA makes concessions about the breadth, depth and comprehensiveness of the search. Due to these limitations, an REA is more prone to selection bias than a systematic review (Barends et al., 2017).

2.1 Search strategy and study selection

PsycInfo and Scopus databases were adopted to identify the studies. The search strategy uses the term "active mobility" in keyword: KEY ("active mobility"), performed in January 2023. The following generic search filters were applied to all databases during the search: Peer-reviewed (excluded reviews), Published from 2021 to 2023, written in English.

Articles were included if they met the following criteria: quantitative or empirical studies; studies in which the effect of variables (moderators and/or mediators) on AM and/or its outcome were measured; studies that report variables correlation with AM; research context belongs to Urban Planning or Behavioural Science.

Articles were excluded if they met at least one of the following criteria: method entirely based on simulation.

Two authors independently analysed the records of the searches. As reported in Fig.1, out of the 61 articles generated by the preliminary search strategy, 7 were excluded because repetitions, 1 (de Melo et al., 2022) was not possible for retrieving, 19 were excluded by reading the title and abstract as they were irrelevant to the study criteria. After reading the full text, 15 more studies were excluded.

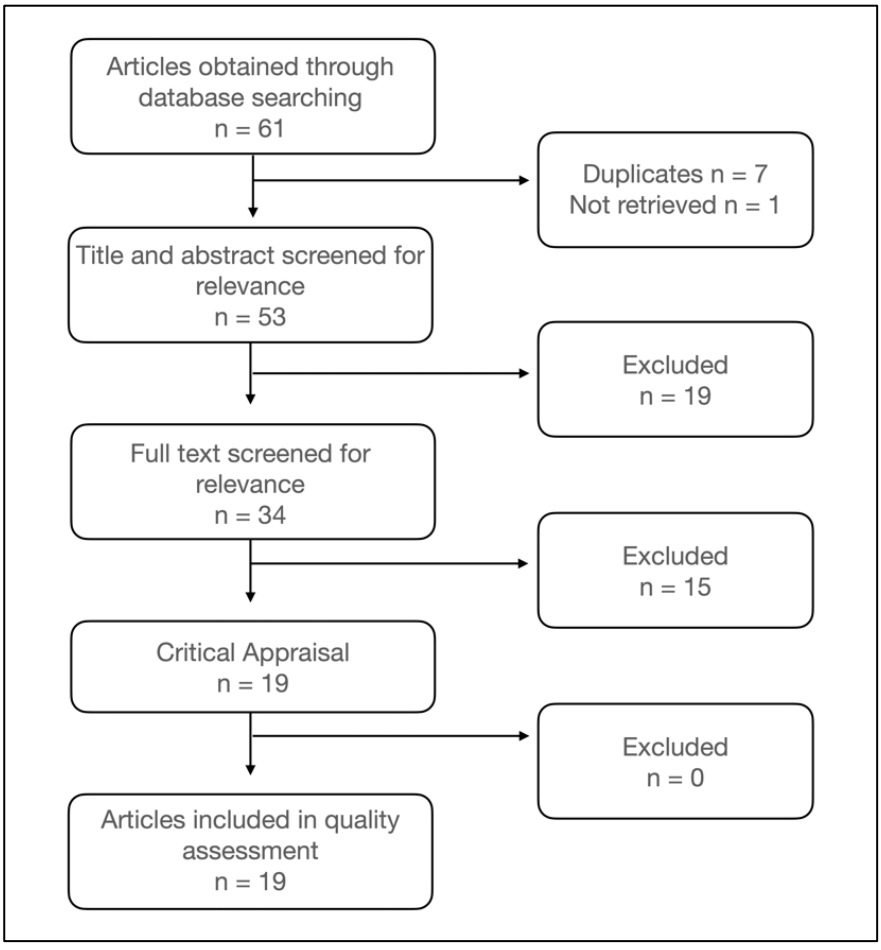

Fig.1 Study selection flowchart

2.2 Assessment of the Studies' Quality

Because of the aims of this review, the main selected articles are traced to cause-and-effect claims. In this case, a study has high methodological appropriateness when it fulfils the three conditions required for causal inference: co-variation, time-order relationship, and elimination of plausible alternative causes. Therefore, studies that use a control group, random assignment and a before-and-after measurement are regarded as the 'gold standard' for effect studies. A six-level classification of appropriateness was used (Tab.1) to determine the methodological appropriateness of effect studies and impact evaluations; it was based on the classification system of Shadish et al. (2002) and Petticrew and Roberts (2008).

Design	**Level**
Systematic review or meta-analysis of randomized controlled studies	AA
Systematic review or meta-analysis of non-randomized controlled and/or before-after studies	A
Randomized controlled study	
Systematic review or meta-analysis of controlled studies without a pretest or uncontrolled study with a pretest	B
Non-randomized controlled before-after study	
Interrupted time series	
Systematic review or meta-analysis of cross-sectional studies	C
Controlled study without a pretest or uncontrolled study with a pretest	
Cross-sectional study (survey)	D
Case studies, case reports, traditional literature reviews, theoretical papers	E

Tab.1 Classification of studies' methodology appropriateness

2.3 Data extraction, synthesis and analysis

The following data were extracted for each of the included studies: sector (Urban Planning, Medicine Science or Behavioural Science) and population (the object of the investigation), study design (reported according to Tab.1) and sample size, variables that affect AM and their assessment tools, and the study quality level (according to Tab.1). Finally, the relevance of the SDGs is assessed by confronting the topics faced by the articles and the goals as well as the target reported in the SDGs framework of the 2030 Agenda for Sustainable Devolvement (United Nations, 2023).

The results are reported in Tab.2. The Active Mobility definition, AM assessment tool, variable affected by AM and their assessment tool, and the main articles' results are reported in Rainieri et al. (2024).

Data were independently abstracted by two authors, and any discordance was resolved by consensus. Because the studies were different in terms of design, setting, interventions, and outcome measures, a narrative synthesis was planned (Popay et al., 2006).

Reference	**Sector & Population**	**Design & Sample size**	**Variables affecting AM & Measures**	**Level**	**SDG**
Giuffrida et al. (2023)	Urban Planning / Dublin city	Case study / None	Accessibility (Hansen measure; PTAL method)	E	9 – 10 – 11
Möllers et al. (2022)	Urban Planning / Germany	Before-after study / 10 cities	Government intervention Weekly days and hours	B	3 – 16
Hasselder et al. (2022)	Behavioural Science/ older adults, Germany (rural	Field study Survey / N = 2137	Perceived distance; Self-rated health;	D	3 – 10 – 11

Reference	Sector & Population	Design & Sample size	Variables affecting AM & Measures	Level	SDG
	communities or small and medium-sized towns)		Environment Walkability Scale (NEWS)		
Hollenbeck et al. (2022)	Behavioural Science / general population, Stuttgart	Within-subject study / N = 46	-	B	3 – 11 – 15
Sundfør & Fyhri (2022)	Behavioural Science / general population, Oslo	Between-subject study / trial: N = 382, control: N = 665, buyer: N = 214	e-bike subvention program	B	10
Lee (2022)	Behavioural Science / General population, Seoul	Survey / N = 20,000	Pedestrian satisfaction	D	10 – 11
Doi et al. (2022)	Medicine Science / older adults, Japan	Survey / N = 4432	Depressive symptoms; Frailty; Cognitive impairment; Disability	D	3
van Hoef et al. (2022)	Behavioural Science / adolescents, Switzerland	Between-subject / trial: N = 48, control: N = 29).	Bicycle promotion program; Cycling skill; Cycling habits; Distance	B	4 – 13
Kurita et al. (2022)	Medical Science / Older adults, Japanese	Meta-analysis / N = 21644	-	A	3
Pisoni et al. (2022)	Urban Planning / European general population	Database analysis /N = 26500	Trip distance, Country, Vehicle ownership, Gender, Type of employment (EU Travel Survey (2018))	D	8 – 11
Brüchert et al. (2022)	Urban Planning / older adults, Germany	Cross-sectional study / N = 1836	Urban design features	D	11
Carboni et al. (2022)	Urban Planning / general population, Valencia, Turin	Cross-sectional study / N = 865	Urban features	D	10 – 11
Said et al. (2022)	Behavioural Science / general population, USA	Cross-sectional study / N = 826	Self-identity; Place Identity; Personal norm Social identity; Work-schedule flexibility; Owning-vehicles; Pedestrian infrastructure; Multimodality (diary)	D	
Mehriar et al. (2021)	Urban Planning / general population, Pakistan	Cross-sectional study / N = 861	Street-length density	D	4 – 8 – 11
Scorrano & Danielis (2021)	Behavioural Science / general population, Trieste (IT)	Cross-sectional study / N = 315	Concern for the global and local environment; Attitude toward physical exercise; Risk aversion towards Covid-19; Theoretical change in policy	D	11
Giansoldati et al. (2021)	Urban Planning / general population (IT)	Cross-sectional study (Survey and Predictive model) / N = 185	Travel time and cost	D	11
Brand et al. (2021)	Urban Planning / general population, EU	Cross-sectional study / N = 3836	-	D	9 – 10 – 11
Fonseca et al. (2021)	Urban Planning / Bologna IT, Porto PT	Cross-sectional study / N = 3836	Travel distance and time; Sidewalk conditions	D	8 – 11
Arranz-López et al. (2021)	Urban Planning / general population, Spain	Cross-sectional study / N = 267	-	D	11

Tab.2 Data extracted

3. Results

The results are presented in the following paragraphs about Active Mobility definition (3.1), Variables affecting Active Mobility (3.2), Active Mobility measures (3.3) and Variables affected by Active Mobility (3.4). At the end of this last paragraph, a Figure summarize all variables.

3.1 Active Mobility definition

Active Mobility appear as a construct poorly described (four articles did not even provide a definition) or with a shared acknowledgement.

Two articles considered just walking as their AM study object, and one article considers public transport as well (Fonseca et al., 2021). In addition to walking, seven articles examine cycling, while two studies included bike-sharing (Said et al., 2022) and e-biking (Brand et al., 2021). Precisely, even if Giuffrida et al. (2023) employed walking and biking to define AM, their study's object was the bike-sharing system. It is worth mentioning that the European Directorate-General for Mobility and Transport defines Active Mobility as "namely walking and cycling" (European Commission).

Moreover, Scorrano and Danielis (2021) encompassed riding personal mobility devices (scooter, rollerblade, skateboard and wheelchair) to AM, while other authors (Carboni et al., 2022; Giansoldati et al., 2021) find a common and general perspective, defining Active Mobility as "all the modes of transport based on human-powered for propulsion".

Besides, it is worth noting that all the articles addressed the concept coherently with the definition provided by EIT Urban Mobility (2020). Thus, Active Mobility is considered by all as a physical activity not undertaken for recreational purposes.

3.2 Variables affecting Active Mobility

Regarding the behavioural science dimensions, Said et al. (2022) reported that the perceived quality of the built environment affects walking propensity but not cycling. It was observed that self-identity (i.e., the concept of seeing AM as a reflection of oneself and embodied ideals) is significant for all the transportation modes, implying that utilising active travel modes is, in part, a consequence of identity-behaviour congruence. Moreover, individual-environment congruence (place identity) is fundamental to the adoption of habitual cycling behaviours. Scorrano and Danielis (2021) stated that respondents who are more concerned about the global environment derive a higher utility from cycling.

It was found that the satisfaction level towards the pedestrian environment during day and night time increases the satisfaction with the neighbourhood (Lee, 2022).

Considering the urban planning field, accessibility is a necessary condition for Active Mobility (Giuffrida et al., 2023). The authors measured the accessibility of the bike-sharing system with a composite index for both active (Hansen-like measure) and passive access (adapting the Public Transport Access Level method).

Within a 20-minute walking distance from the participants' homes, the strongest associations with walking for transport were found for small stores, pharmacies, and bakeries. At the same time, the bus stop showed the weakest associations (Hasselder et al., 2022).

Mehriar et al. (2021) stated that the frequency of AM behaviours around home increases when the amount of street-length density (connectivity) is more than 137 m/m^2 (for commuting) and 10.33 m/m2 (for non-commuting), while the opposite effect was observed around workplaces, where lower street-length density was connected to higher AM behaviours.

Fonseca et al. (2021) showed that travel distance, travel time and sidewalk conditions were the main barriers to utilitarian walking. Giansoldati et al. (2021) confirm that travel time and cost play a relevant role in determining transport choice. They found that being commuters lowers the disutility from the time spent

cycling or walking. The authors calculated that the active modes ranges were, on average, equal to 1.3 Km for walking and 2.1 Km for cycling, while the maximum distance for walking was 3 Km and 4 km for cycling.
Brüchert et al. (2022) reported that both AM and car-oriented users rated urban features (such as road safety, surface quality, good lighting, and walking space) as important, but with different magnitude, especially for speed reduction. Carboni et al. (2022) stated that cyclists are somewhat affected by safety issues and concerned about sharing space with other vehicles.
About the Socio-demographics, it seems clear that a healthier and younger population is more likely to exhibit AM behaviours. The fact that drinking habits are associated with AM may suggest that people are more willing to use AM for pleasure reasons.

3.3 Active Mobility measures

Literature adopted several assessment tools. Only Pisoni et al. (2022) used an indirect data source by deriving information from the EU travel survey (edition of 2018 with 26,500 responses) that allowed the association of socio-economic and demographic attributes with user choices concerning transport and mobility. Data earned concerned: availability of cars and public transport services, daily mobility in terms of purposes and modes used, number of trips, trip frequency, durations, distances, intermodality (e.g., connections between rail and air transport), main problems experienced, long-distance trips in the last 12 months.
Mollers et al. (2022) used counting stations (provided by Hystreet for pedestrian counts by EcoCounter for cyclists). Bollenbach et al. (2022) adopted a walking-triggered e-diary, which was accomplished using an interface between a smartphone (for electronic diaries, GPS- and transmission tower location tracking) and a hip-worn accelerometer. Similarly, Sundfør et al. (2022) used app-based questionnaires, which had a one-day travel diary section, starting with an explanation of the procedure for how to define a trip, travel mode, trip purpose (14 categories from the Norwegian National Travel Survey), distance and time spent. Additionally, the app collected position and speed through GPS and accelerometer. Notably, the authors distinguished between biking for transport and exercise.
Said et al. (2022) assessed participants' travel habits, asking them to complete a "weekly travel diary", which collected the number of trips, travel modes and trip purposes.
Questionnaires represented the main method. Hesselder et al. (2022) measure if the participants walk for transport by a single item (Do you walk for transport with a duration of at least 5 minutes?). Arranz-López et al. (2021) asked for the respondents' actual walking time to daily and non-daily retail destinations (real accessibility) as well as their walking time-willingness (potential accessibility). Doi et al. (2022) and Kurita et al. (2022) developed and applied the Active Mobility Index (AMI) questionnaire to assess physical and social activities.
Summarising the content of the questionnaires, typical items inquired about the mode choice, or a combination of modes (Bruchert et al., 2022; Carboni et al., 2022), in relation to weather conditions (Scorrano & Danielis, 2021; Van Hoef et al., 2022) and if the trip was a communing one or not (Mehriar et al., 2021) or the purpose of the trip in general (Fonseca et al., 2021). Additional items could ask for trip characteristics, such as travel time and cost (Giansoldati et al., 2021), vehicle ownership, and public transport accessibility (Brand et al., 2021).

3.4 Variables affected by Active Mobility

Brand et al. (2021) confirmed the mediating role of trip purpose on CO_2 and highlighted how travel to work or education produced the largest share of emissions; there were also considerable contributions from social and recreational trips.
Giuffrida et al. (2023) reported that the higher the accessibility of the bike-sharing system, the higher the transport equity and social inclusion. Therefore, the authors employed the concept of "horizontal equity", i.e.,

the spatial distribution of bike-sharing stations. To perform this analysis, they used the Gini index, defined mathematically as the ratio of the area that lies between the line of perfect equality (bisector of the first quadrant of the Cartesian plane) and the Lorenz curve. In the case of this article, it was considered the distribution of the accessibility measure among the zonation of the city under analysis.

Pisoni et al. (2022) calculated that shifting 10% of car-based transportation to AM can save more than 10 billion EUR per year. The external cost was assessed in terms of Well-to-Tank emissions, noise, habitat, congestion, climate, air pollution, and accidents.

Kurita et al. (2022) reported how a larger living space with physical activity is protectively associated with sarcopenia and its indices.

Bollenbach et al. (2022) found that those who were walking in a greener environment were more calm or more relaxed. The affective state can be described by: calmness and energetic arousal, both predicted by social interaction intensities while walking in green areas.

Said et al. (2022) reported that walking contributes to a good mental map of the neighbourhood, while biking is related to multimodality, openness to learning, and variety seeking, suggesting it is more connected to being open to change and learning new skills.

As mentioned, Fig.2 offers a comprehensive representation of the relation between the variables.

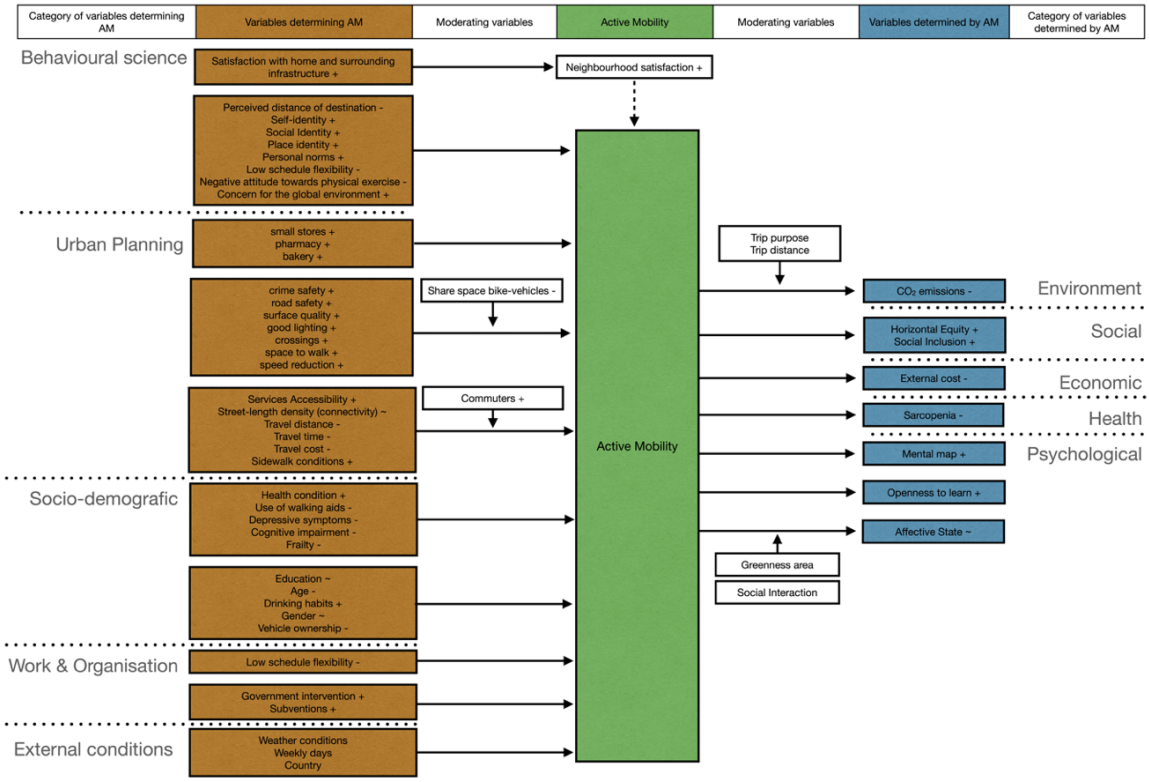

Fig.2 Comprehensive framework of Active Mobility. All the variables are characterised by a sign: + when it increases AM, - when it decreases AM, ~ when the relation is ambiguous. Note that "neighbourhood satisfaction" has a potential, but not demonstrated, influence on Active Mobility

3.5 Which SDGs were mainly addressed by Active Mobility?

The analysis showed that the 11th SDG (Make cities and human settlements inclusive, safe, resilient, and sustainable) was addressed fourteen times. The 11.2 target is the one main concern for AM. Specifically, the concept of transport accessibility (pedestrian path and bike sharing), thus the location of the resources and

the spatial range of transports, emerges as a strategy for reaching inclusiveness while offering solutions for sustainable transportation (Arranz-López et al., 2021; Giuffrida et al., 2023).
Another study works in this direction (Scorrano et al., 2021), claiming that those who show AM behaviours were more concerned about the global environment, somehow addressing the target 11.3.2.
The 10th SDG (Reduce inequality within and among countries) was addressed six times. Accordingly, a subvention programme intended to support active transporters' purchases (e.g. bike and e-bike) can reduce inequality by offering the opportunity to obtain functional, new, well-designed transports to everybody.
Furthermore, to promote active mobility, governments need to invest in infrastructure that enables actual and perceived safety (Carboni et al., 2022); in this sense, the promotion of active mobility would achieve a higher state of well-being. Thus, the provision of a safe environment that incentivises the use of active mobility means would bring the extremes of society closer together.
The 3rd SDG (Ensure healthy lives and promote well-being for all at all ages) was addressed four times. Summering the results, it was found that good health conditions and low frailty were negatively related to AM choices (Hesselder et al., 2022), which in turn reduces Sarcopenia, an age-related loss of skeletal muscle mass and strength (Kurita et al., 2022).
The 8th SDG (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all) was found relevant three times. The emissions analysis for trip purposes highlighted the relative importance of the systematic trip from home to work/education place (Brand et al., 2021). This finding suggests that the work-organisations have the potential to foster the adoption of AM choices.
Regarding the 4th SDG (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), addressed two times, it is worth saying that the Education concept remains a fuzzy factor. While some authors found that AM was connected to a higher educational level (Doi et al., 2022), others reported it was more probable in low education conditions (Pisoni et al., 2022). Interestingly, biking was related to openness to learning, suggesting it is more connected to being open to change and learning new skills (Said et al., 2022). Moreover, Lee (2022) found no correlation between the educational environment and neighbourhood satisfaction.
A particular mention is due to the cycling promotion programme and bicycle training for adolescents in high school (Van Hoef et al., 2022), which demonstrate how working towards AM can contribute to fulfilling the indicator 13.3.1 (citizenship education for sustainable development mainstreamed in national education policies and student assessment).
For a more comprehensive description, see Rainieri, Carra, Richiedei and Pezzagno (2024).

4. Discussion

In this section, the results are commented on, as well as the connections between Active Mobility and Social Sustainability, and the scientific community's commitment towards the topic.

4.1 Active Mobility

In light of the elements raised by the considered articles, Active Mobility can receive the following comprehensive definition: physical activities undertaken for transportation, not for recreational purposes, which encompass walking, cycling, e-bike, bike-sharing, public transport, and all the modes of transport based on human-powered for propulsion. To be precise, it is reasonable to acknowledge that every journey inherently includes walking. As highlighted by Busi (2011), all the odd-numbered connections within the sequence of transportation modes manifest as pedestrian movement.
The assessment of Active Mobility behaviours considered the collection of trajectories and feedback from mobile app data, and it appears promising. However, the data are rough and prone to misunderstandings, such as when distinguishing walking from biking. It was reported that 75% of professionals stated they were

only partly able to solve their tasks using the data available to them. Additionally, 60% of the respondents were able to quantify the modal share for cycling for their zone, while only 51% were able to state the main cyclists' trip purpose. Nonetheless, having these kinds of data could be beneficial for both the public and private sectors that are dealing with active mobility (Werner et al., 2021).

Moreover, the assessment of variables affecting AM could be beneficial for a better organisation of the city and its policies (e.g., Carra et al., 2022). Considering the impacts, active mobility behaviours yield beneficial outcomes in the environmental, social, economic, health, and psychological realms.

Considering the path length perception, the e-bike has the potential to change people's attitude towards AM, offering a more comfortable and fast mode of transportation, able to change people's mental city map. However, the lack of (perceived) road safety remains currently the main barrier to cycling (Maas & Attard, 2022). Generally, all the research outcomes highlighted that cycling presents multitude of challenges for urban planners. These primarily revolve around effectively offering infrastructure for organising trips and providing supportive equipment that can mitigate concerns related to weather conditions.

However, it was stated that increasing the bike infrastructure (cycle paths) would not translate into an increase in active mobility since the bike would substitute some trips currently made by foot (Scorrano et al., 2021). Taking this statement as a challenge, an integrated transportation system (such as general subscription for bike-sharing, public transport, and parking) could change this trend since it offers high flexibility of choice that can vary according to conditions, such as weather, weekly days, time, and travel purpose.

Lee (2022) noticed that the pedestrian environment serves other modes of transportation, such as bicycles, micro-mobility services, wheelchairs, and baby strollers. This means it may be more than pedestrians, and policymakers should consider this in the planning phase. The question could be: Should cities' public administrations allow other users to utilise the sidewalks? To respond, it is important to note that allowing mixed-use sidewalks has a dual effect. If only a few individuals utilise sidewalks, it can enhance comfort (especially for males). However, increasing the number of potential users enhances both the perception of safety and the appeal of the sidewalks. This statement is in keeping with the concept of the social signifier: the presence or absence of people serves as a signifier, meaning some behaviours are socially allowed or not (Norman, 2010). Social signifiers are not guarantees, but they are strongly suggestive.

Results showed implications for practitioners. For instance, active mobility behaviour change campaigns should focus on both cycling and walking (Said, 2022). When designing a policy, decision-makers should implement an integrated approach to avoid negative effects (due to a possible shift from public transport to active mobility, which is not desirable); this integrated approach should increase infrastructure availability, foster an active mobility culture and discourage the use of cars (Pisoni, 2022).

Current bicycle users, as well as motorcycles, are not particularly sensitive to the time, speed, and distance of their trip, as their modal preference is more probably a matter of life choice. This stresses how promoting a cultural value related to walking and biking can be beneficial, and overall, this can be a very useful hint for policymakers to help promote active mobility. However, it is worth noting that the countries more mature in providing active mobility infrastructures are different from those historically famous for vehicle companies, such as Italy, France, the UK and Germany.

Finally, observing the Sustainable Development Goals, it looks clear that addressing active mobility could have a positive effect in many directions, starting from enhancing the cities' inclusiveness and sustainability (SDG 11th), passing through the reduction of inequalities (SDG 10th) and promoting well-being and healthy lifestyle (SDG 3rd).

4.2 How were the SDGs connected to Social Sustainability?

The analysis confirmed the connection between the impacts of AM and social sustainability. This work suggests adopting active mobility data, the measurements of its impacts and the moderating variable in order to assess

and benchmark part of social sustainability's complexity. Recalling the definition of social sustainability, strengthening the set of policies, rules and infrastructures that enhance accessibility and AM choices, in turn, reinforces the social dimensions of equality and inclusiveness. Therefore, active mobility data can contribute to assessing indicators 9.1.2[1], 11.2.1[2], and 16.1.4[3], while those indicators advance to qualify equity and inclusiveness measures.

Moreover, the correlation between active mobility and the openness to learn is worth mentioning. AM promotes a mindset of adaptability and innovation. By actively engaging in the environment and being physically present, individuals become more aware of their surroundings and the need for change. This mindset can extend beyond transportation and inspire a willingness to learn, adapt, and embrace new ideas and technologies. By being open to learning, individuals can contribute to long-term social sustainability through their choices and actions. In this regard, openness to learn appears to be linked to indicator 4.7.1[4].

The opportunity to interact with others in green areas can enhance people's calmness and energy levels. The restorative effect of nature, social interaction and connection, physical activity, exposure to natural light and fresh air, and the aesthetics of green spaces all play a role in promoting a sense of tranquillity and vitality. Incorporating green spaces into urban environments and encouraging their use can contribute to the well-being and social sustainability of communities. About this aspect, the indicator 11.7.1[5] can be considered as a contribution to the social sustainability.

In summary, this research highlights the links between the SDGs 11th, 9th, 4th, and 16th with the overall framework of social sustainability.

4.3 Scientific community and public engagement

In this session, we aim to explore the extent of attention dedicated by scientific journals to Active Mobility and evaluate the availability of scientific materials in terms of open-access and proprietary resources. Therefore, we analyse the knowledge accessibility for public engagement on this matter.

Tab.3 reported the references of the articles extracted, the title of the journal that published the article, its main topic and whether the articles were open-access or not.

The main sources of information are journals dealing with transportation research, followed by urban planning and medicine science. Fewer articles originated from journals relative to policy, psychological studies, and sustainability. One source was generalist.

Just 8 articles were free and available for public use, while 11 were not open access. This finding suggests that less than half of the knowledge used in this review would have been freely accessible. This can be a problem since urban planning is closely linked to public participation in decision-making and co-design of cities and policies.

Reference	Journal's title	Main Journal's topic	Open access
Giuffrida et al. (2023)	Journal of Transport Geography	It is focused on the geographical dimensions of transport, travel and mobility	No
Möllers et al. (2022)	Transportation Research Part A: Policy and Practice	It deals with policy analysis, planning, interaction with the political, socioeconomic and physical environments, and management and evaluation of transport systems.	No

[1] Passenger and freight volumes, by mode of transport.
[2] Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities.
[3] Proportion of population that feel safe walking alone around the area they live after dark.
[4] Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment. This indicator appears also as the 12.8.1, 13.3.1.
[5] Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.

Reference	Journal's title	Main Journal's topic	Open access
Hasselder et al. (2022)	BMC geriatrics	It deals with all aspects of the health and healthcare of older people.	Yes
Hollenbeck et al. (2022)	Frontiers in Psychology	Clinical research, cognitive science, perception, consciousness, imaging studies, human factors, and animal cognition to social psychology.	Yes
Sundfør & Fyhri (2022)	Journal of Transport & Health	It evaluates or informs the development of interventions and policies to improve population health, or that make a genuinely original contribution.	No
Lee (2022)	Sustainability	Environmental, cultural, economic, and social sustainability of human beings.	Yes
Doi et al. (2022)	Journal of the American Medical Directors Association	The journal covers all aspects of long-term care and geriatrics.	No
van Hoef et al. (2022)	Frontiers in Psychology	Clinical research, cognitive science, perception, consciousness, imaging studies, human factors, and animal cognition to social psychology.	Yes
Kurita et al. (2022)	Journal of Cachexia, Sarcopenia and Muscle	Journal dedicated to cachexia and sarcopenia, as well as to body composition and its physiological and pathophysiological changes during the lifespan and in response to different illnesses from all fields of the life sciences.	No
Pisoni et al. (2022)	Science of the Total Environment	Journal dedicated to the total environment, which interfaces the atmosphere, lithosphere, hydrosphere, biosphere, and anthroposphere.	No
Brüchert et al. (2022)	Cities & health	Journal mainly focused on public health and the health of planetary systems.	No
Carboni et al. (2022)	Transportation research procedia	Journal mainly focused on social science area of transportation research.	Yes
Said et al. (2022)	International journal of sustainable transportation	Focuses on interactions of transportation systems with urban subsystems and publishes interdisciplinary research on global or local sustainable transportation.	No
Mehriar et al. (2021)	Applied Sciences	The journal covers all aspects of applied physics, applied chemistry, engineering, environmental and earth sciences, and applied biology.	Yes
Scorrano & Danielis (2021)	Research in Transportation Economics	The journal deals with the economic aspects of transportation, government regulatory policies regarding transportation, and issues of concern to transportation industry planners.	No
Giansoldati et al. (2021)	Research in Transportation Economics	The journal deals with the economic aspects of transportation, government regulatory policies regarding transportation, and issues of concern to transportation industry planners.	No
Brand et al. (2021)	Transportation Research Part D: Transport and Environment	It is dedicated to environmental impacts of transportation, policy responses to those impacts, and their implications for the design, planning, and management of transportation systems.	No
Fonseca et al. (2021)	ISPRS International Journal of Geo-Information	Journal of wide interest, including Spatial data modeling, Spatial data management, Spatial analysis and decision making.	Yes
Arranz-López et al. (2021)	Journal of Maps	Inter-disciplinary journal for researchers to publish maps and spatial diagrams across the physical and social sciences.	Yes

Tab.3 Sources' Journal and resource assess type

5. Conclusion

The review analysed how scientific literature quantifies Active Mobility, its antecedents, impacts, and how impacts can contribute to defining Social Sustainability. The findings of the Rapid Evident Assessment method provided a comprehensive framework of definitions, variables that influence active mobility behaviours and those influenced by it, challenges in its promotion, knowledge gaps, and correlation with SDGs.

- The comprehensive definition of Active Mobility encompasses various physical activities undertaken for transportation purposes, such as walking, cycling, e-bike, bike-sharing, and public transport. The main

methods for AM assessment were surveys and diaries. Nonetheless, the assessment of Active Mobility behaviours through mobile app data is still in its early stages and faces challenges in accurately distinguishing between different modes of transportation. Further research could focus on exploring innovative and accurate data collection methods that can effectively capture Active Mobility behaviours and provide reliable insights for decision-making;

- Several variables influence Active Mobility behaviours, including behavioural science factors, urban planning considerations, and socio-demographic characteristics. Positive attitudes, work schedule flexibility, consistency between people and place identity, and satisfaction with home and infrastructure were associated with higher Active Mobility behaviours. Additionally, access to services, safety, good street maintenance, and environmental factors played a significant role;
- The impacts of Active Mobility were identified across various domains, including environmental, social, economic, health, and psychological aspects. Active Mobility contributes to equity and inclusion, promotes mental well-being, reduces CO_2 emissions, enhances physical health, and reduces external costs associated with vehicles. However, the adoption of Active Mobility is influenced by factors such as trip distance, purpose, and perceived road safety. In this regard, the use of e-bikes has the potential to change attitudes towards Active Mobility by offering a more comfortable and faster mode of transportation. Therefore, further research could involve a comparative analysis of Active Mobility initiatives implemented in different cities or regions, evaluating their outcomes, and identifying successful strategies and lessons learned;
- Challenges in promoting cycling culture and addressing safety concerns remain. Integrated transportation systems and a focus on both cycling and walking were suggested as effective strategies for promoting Active Mobility. Because of the nature of this research approach, this article could not delve deeply into the cultural factors influencing Active Mobility behaviours. Investigating cultural attitudes, values, and norms related to transportation choices and examining how cultural factors interact with other variables could provide valuable insights for designing effective interventions and policies;
- Despite the positive impacts of Active Mobility on various domains, there is limited discussion on the long-term effects of Active Mobility interventions. Therefore, further research could explore the sustainability of Active Mobility behaviours over time and investigate factors that contribute to their long-term adoption;
- The connection between Active Mobility and the Sustainable Development Goals (SDGs) was evident, with positive effects on inclusiveness, sustainability, reducing inequalities, and promoting a healthy lifestyle. The analysis also highlighted the role of Active Mobility data in assessing social sustainability indicators and promoting openness to learning and interaction in green spaces;
- Regarding the scientific community's engagement, most of the articles were published in transportation research journals, and limited open-access articles were available, posing a challenge to public engagement and participation in decision-making processes related to urban planning.

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Image sources

Figg.1 - 2: Authors' elaboration

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