



The role of the perceived environment for recreational walking among adults in socioeconomically disadvantaged situations: A study using walk-along interviews

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ABSTRACT

Background: Persons in socioeconomically disadvantaged situations (PSEDS) are generally less likely to engage in recreational walking (RW) compared to higher socioeconomic groups and are often more dependent on their local environment. Studies on RW have primarily focused on the role of the built environment for the general adult population and the older population in urban areas. The aim of this study is to qualitatively identify the perceived environmental factors affecting RW among PSEDS in peri-urban areas.

Methods: In two peri-urban municipalities in Belgium, walk-along interviews were conducted until data saturation with a purposeful convenience sampling of 38 PSEDS (25-65y/o) to identify local environmental factors affecting RW. A subsample of 22 participants joined a focus group ($n = 4$) to categorize the identified factors into environmental types (physical, sociocultural, political, and economic) of the Analysis Grid for Environments Linked to Obesity (ANGELO) framework. The interviews were transcribed and analyzed thematically using Maxqda 2022.0.

Results: The information environment (dissemination, retrieving and understanding of information) was added to the ANGELO framework, highlighting the importance of digital literacy. Availability and accessibility of well-maintained walking surfaces, toilets, street lighting and seating options (physical environment), social support, dog-ownership, stigmatization, social isolation, and a sense of belonging (sociocultural environment) and indirect costs (economic environment) were identified as important environmental factors in RW among PSEDS. The identified political and economic factors are intertwined with the other environments.

Conclusions: Perceived environmental factors affect RW among PSEDS and peri-urban settings offer specific challenges. Local governments should incorporate citizen perception into decision-making processes to create supportive environments that have the potential to promote RW among PSEDS in a peri-urban setting.

1. Introduction

Despite the well-documented health benefits of physical activity (PA), evidence from 28 European countries shows that more than one-third of adults are not sufficiently physically active to gain health benefits (Nikitara et al., 2021). Persons in socioeconomically disadvantaged

situations (PSEDS) are less likely to engage in recreational walking (RW), the most common leisure-time PA in industrialized countries, compared to higher socioeconomic groups (Stalsberg & Pedersen, 2018). The local environment may play an important role in RW among PSEDS who are often more dependent on their direct environment compared to higher socioeconomic groups due to their smaller activity

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radius (Feuillet et al., 2016; Shareck et al., 2014; Sharkey & Faber, 2014). The aim of this study is to qualitatively identify the perceived environmental factors affecting RW among PSEDS between 25 and 65 years old in peri-urban areas.

1.1. The role of the environment for RW among PSEDS

Increasing attention has been paid to the role of the neighborhood as an important place for people to engage in PA (Smith et al., 2017). Neighborhood characteristics (mostly built environment features) as determinants of walking have been studied in particular in walking for transport, and to a lesser extent in recreational walking (Feuillet et al., 2016). However, environmental influences differ by walking purpose (Wang et al., 2021).

Existing research on RW has primarily focused on the role of the built environment and to a lesser extent on the social environment, especially concerning adults (e.g., Chaix et al., 2014; Christian et al., 2017; Nehme et al., 2016; Sugiyama et al., 2014) and the older population (e.g., Christman et al., 2020; Corseuil Giehl et al., 2017; Yun, 2019). While some studies investigated differences in RW between socioeconomic groups (e.g., Christie et al., 2022; Dias et al., 2020; Sugiyama et al., 2015), limited studies focused on PSEDS specifically, often relying on quantitative approaches (e.g., Hilland et al., 2020).

The built environment such as walkability (based on the mix of land use, street connectivity and residential density) (Chaix et al., 2014; Christian et al., 2017; Dias et al., 2020; Sugiyama et al., 2014; Yun, 2019), proximity and access to green and open spaces (Chaix et al., 2014; Christian et al., 2017; Sugiyama et al., 2014), neighborhood aesthetics (Christian et al., 2017; Sugiyama et al., 2014), safety from crime (Christian et al., 2017; Nehme et al., 2016; Sugiyama et al., 2014) and walking facilities (Chaix et al., 2014; Nehme et al., 2016) have been positively associated with RW, irrespective of socioeconomic background. Previous research that focused on the perceived sociocultural environment and walking was mostly based on survey data and covered aspects such as social support, social capital, safety and social cohesion (Caspi et al., 2013; Iroz-Elardo et al., 2021; Sawyer et al., 2017; Van Cauwenberg et al., 2014; Van Holle et al., 2016), but few provide a broader view of the social environment across domains (Iroz-Elardo et al., 2021). A systematic review of Hilland et al. (2020) on correlates of walking among disadvantaged groups showed that only social support from friends and family and perceived safety had a consistent positive association with RW, while neighborhood aesthetics, objective and perceived walkability, proximity to destinations, green and open spaces were inconsistent.

In terms of associations between the environment and RW mixed findings exist between objective and perceived measures of the environment (Orstad et al., 2017). Objective measures typically rely on spatial data using geographic information systems, while perceived measures are mostly derived from surveys and to a lesser extent from interviews (Peters et al., 2020). Some studies suggest that perceived environmental factors may be better predictors of self-reported health behaviors, such as RW, as they provide more insight into which environmental features are more salient (Hilland et al., 2020). PSEDS tend to perceive their environment more negatively than persons with a high SES (Sugiyama et al., 2015). However, few studies provide in-depth insights into perceptions and experiences towards RW of PSEDS. Therefore, it is important to examine perceptions of this specific group in a qualitative way in relation to a broader framework beyond the built environment research (Middleton, 2021).

Most of the aforementioned studies were conducted in urban areas, while the environmental factors affecting RW may differ between urban, peri-urban and rural areas (Whitfield et al., 2019). Few studies have been conducted on RW in rural areas, mostly in the United States (Baxter et al., 2022; Li et al., 2018; Stewart et al., 2016). A comparative study between urban and rural areas found that similar built characteristics, such as roads, sidewalks, paths and traffic were associated with RW.

However, rural residents reported less social support, crime and variety of destinations (Whitfield et al., 2019). Research specifically focusing on peri-urban areas that have both urban and rural features is scarce (Olson et al., 2019). Nevertheless, peri-urban areas are increasingly emerging in Europe and the physical inactivity levels are higher in rural and peri-urban areas compared to urban areas (Moreno-Llamas et al., 2021). Furthermore, socioeconomic disadvantage is not only an urban phenomenon, although often less visible in peri-urban and rural areas (Marissal et al., 2013). Moreover, PSEDS in peri-urban and rural areas encounter different challenges regarding accessibility, physical and social mobility, compared to urban areas (Camarero & Oliva, 2019). Translating the context of urban or rural to peri-urban areas is complex (Van Dyck et al., 2011). In Belgium, peri-urban areas encounter specific challenges, such as limited transport opportunities and inaccessibility of infrastructures, without the economics of scale or budgets available in cities to address these issues. Consequently, actions implemented in urban contexts cannot be readily applied to peri-urban settings (ILVO, 2020; Rijsbosch, 2016). Feuillet et al. (2016) suggest that the impact of the environment on individual behaviors should be examined at a local level due to the spatial heterogeneity in the relationship between walking and the environment. Therefore, it is crucial to comprehend the role of perceived environmental factors in RW among PSEDS in peri-urban areas specifically.

1.2. Conceptual framework

Multiple socio-ecological frameworks exist to capture people's interactions with the environment in which they live and work, such as the ecological model of Bronfenbrenner (1977), the ecological model of four domains of active living (Sallis et al., 2006), and the socioecological model of PA determinants in low socioeconomic contexts (Rawal et al., 2020). In this paper, the conceptual framework is largely based on the Analysis Grid for Environments Linked to Obesity (ANGELO) framework (Swinburn et al., 1999). This is a tool for identifying and categorizing various obesogenic components (i.e., barriers to adopt a healthy diet and active lifestyle) in the environment. It divides the environment into two sizes: micro-environmental settings such as homes and neighborhoods, and macro-environmental sectors such as health or transportation systems and leisure industry. In addition, the environment is divided into four types: the physical (e.g. available recreational facilities, and less visible factors, such as available training options), the economic (costs), the sociocultural (attitudes, beliefs, values) and the political environment (rules). The ANGELO framework has proven its usefulness in environmental research related to PA, both in identifying and categorizing environmental determinants (e.g., Belon et al., 2014).

In summary, so far, no studies addressed the role of the perceived local environment in peri-urban areas on RW, specifically among PSEDS. In this paper, we define the local environment as the participants' perceived local environment, with the municipality as an absolute boundary (Smith et al., 2010). The following research question will be answered using a qualitative study design: What perceived local environmental factors play a role in RW among PSEDS living in a peri-urban environment?

2. Methods

This study is part of the CIVISANO-project, a research project using mixed-methods to investigate the role of objective and perceived environmental factors in PA and eating behaviors among PSEDS in two peri-urban municipalities in Belgium. A detailed description of the complete study protocol can be found elsewhere (D'Hooghe et al., 2022).

2.1. Setting

Two medium-sized peri-urban municipalities, Duffel and Herselt, provided the setting for this study. Both are in the province of Antwerp,

in the Flemish Region of Belgium. Duffel is a monocentric municipality of 22.6 km² and 17,664 inhabitants corresponding to an average density of 781 inhabitants/km². Herselt consists of several sub-municipalities and covers an area of 52.4 km² with 14,541 inhabitants corresponding to an average density of 277 inhabitants/km².

2.2. Recruitment and study sample

Purposeful convenience sampling was used to recruit PSEDS in both municipalities. Recruitment was done through door-to-door visits in disadvantaged neighborhoods, at food distributions, local social organizations, through the municipality journal, social media, a snowball-method and through an invitation in the pre-distributed Civisano-questionnaire. Participants had to be between 25 and 65 years old, reside in either municipality, be able to walk independently (walking aids were allowed) and be socioeconomically disadvantaged by meeting at least two of the following criteria: low educational level (=no tertiary education degree), no current job, low perceived socioeconomic status (\leq five on a scale of ten, with ten being the highest perceived SES), perceived financial difficulties (=difficult to very difficult to make ends meet per month). Participants who attended both the walk-along and the focus group sessions were given a €10 voucher as incentive to redeem at local stores.

This study was approved by the Medical Ethics Committee of Ghent University Hospital (BC-09260) and was conducted in line with the recommendations of the Belgian Data Protection Authority. All participants signed a written informed consent form prior to participation.

2.3. Data collection

Considering our target group, we chose walk-along interviews. Participants can discuss their experiences and perceptions during a walking interview, while interacting with and interpreting the environment they are talking about (Carpiano, 2009). This reduces the issue to recall perceptions at the time of exposure, facilitates communication and allows observation of the walking behavior in relation to context-specific information. Walk-along interviews have previously been used to study the relationship between environment and PA, mostly for walking as transport (e.g., Van Cauwenberg et al., 2012), walking in group (e.g., Kassavou et al., 2015) or park-based walking (e.g., Veitch et al., 2022). In this study, walk-along interviews were used to capture the role of the local environment in RW among PSEDS.

Data collection took place between June and November 2021.38 walk-along interviews were conducted by the first author. There were 32 individual walk-along interviews and three walk-along interviews with two participants, as specifically requested by the participants. Data saturation was reached after 35 walk-along interviews, so no additional information was attained in the 3 subsequent interviews (Hennink & Kaiser, 2022). Prior to the walk, a brief questionnaire was completed to collect demographic information (age, sex, educational status, work status, perceived financial difficulties, subjective SES, housing situation, net income, monthly food expenses, nationality, perceived health, perceived functional limitations, and weight and length to calculate BMI) and frequency of RW.

The researcher instructed the participant to start the walking route that he/she sometimes takes for leisure and to share what aspects in the environment invite or hinder him/her to walk there. The researcher pointed out that environment can be broadly interpreted, not only referring to the physical 'visible' environment, and that it can also include feelings of safety, social, economic or political aspects. The researcher asked explicit consent to record the conversation.

As experts, the participants chose the route and the topics they talked about. The walk-along started and ended at the home of the participant. Two participants did not feel comfortable to meet at their home and chose another starting point in the same neighborhood. During the walk, participants were reminded of the aforementioned instructions. Follow-

up questions were asked to obtain more information about what factors facilitate or hinder RW. The walks lasted between 38 and 137 min, with an average of 74 min. The walk-along interview was pilot tested before the start of the study with a member of the target group by two students (JG and SVDV).

A few weeks later, participants were invited to engage in a focus group to share and discuss the experiences and findings from their walk-along interview. The focus group served as a member-check, participants could verify and adjust the summary findings (based on their interviews) that the researcher presented (Goldblatt et al., 2011). The participants were asked to sort the identified environmental factors in the four types of environment articulated in the ANGELO framework (physical, sociocultural, economic and political environment) (Swinburn et al., 1999). A moderator (SuD) and an observer (YI) were present at the focus groups. 22 out of the 38 participants took part in the focus groups ($n = 4$, two in each municipality, 6, 7, 6 and 3 participants respectively). Each focus group lasted 2 h. The reasons for non-participation in the focus groups were no time ($n = 4$), sickness ($n = 3$), fear of COVID-19 ($n = 3$), not known ($n = 2$), no desire to participate further ($n = 4$).

2.4. Data analysis

Descriptive statistics of the brief questionnaire were calculated using SPSS. Data from the tape recordings were transcribed verbatim. MaxQDA 2022.0 was used for analysis. Initial open coding of 7 of the 38 interviews was conducted separately by two researchers (SuD and YI). These codes ($n = 164$) were compared and discussed to create an initial coding tree. The initial codes were grouped into deductive themes that emerged in literature through a thematic analysis, following the categories of the ANGELO framework (Rawal et al., 2020; Sallis et al., 2006; Swinburn et al., 1999) which led to the creation of the final coding tree after multiple discussions with all co-authors. An overview of the themes and subthemes in the coding tree can be found as Supplementary File 1. All 38 interviews were analyzed by the first author (SuD). 25% of the interviews ($n = 10$) were double analyzed by a second researcher (YI). The four focus group discussions were analyzed using the same coding tree by the first author.

3. Results

3.1. Participant characteristics

The characteristics of the 16 male and 22 female participants are shown in Table 1. Individual participant characteristics can be found as Supplementary File 2. Almost three quarters of the participants had no paid work, mainly due to illness or disability. They reported more 'poor health', more 'functional limitation', and were more obese compared to

Table 1
Participant characteristics.

DEMOGRAPHIC INFORMATION ($n = 38$)	
Age (years)	48.1 \pm 11.6
Sex (% men)	42.1%
SES (% no higher education)	76.3%
SES (% no work)	71.1%
SES (% perceived financial difficulties)	60.6%
SES (% subjective SES \leq 5)	68.5%
Housing (% house owner)	47.4%
Net salary (% <1500 €/month)	52.7%
Monthly expenses food (% <150 €/month)	86.4%
Nationality (% non-Belgian)	13.2%
BMI (% overweight or obese)*	64.8%
Subjective health (% good perceived health)	39.5%
Perceived functional limitation (% no problems)	28.9%
RW behavior (% weekly or daily RW)	52.6%

*Data missing for one respondent ($n = 37$).

the general population (Renard et al., 2021). About half of them reported to go for RW on a daily to weekly basis.

3.2. The perceived peri-urban environmental factors affecting RW among PSEDS

The findings are categorized into five types of environments. We were guided by the four types of environments articulated in the ANGELO framework: 1) physical, 2) sociocultural, 3) economic and 4) political environment. However, during the focus groups, participants suggested adding another type of environment: 5) information environment. Almost all topics had both positive and negative influences on RW behavior dependent on the angle and choice of words of the participants. Some topics were brought up related to multiple environments, indicating that these are connected.

3.2.1. Perceived physical environment

Themes in the perceived physical environment include the functional PA environment, the aesthetic physical environment, traffic safety, facilities, and the natural environment.

The walk-along interviews showed the importance of the functional PA environment for RW in terms of the availability and width of sidewalks or walking trails and the maintenance of these walking surfaces. Some participants articulated that both the absence and poor condition (e.g., damaged pavements) affect accessibility, especially for people with mobility impairments. Illustrated by a 29-year-old woman: *"We avoid the wood, because the roots stick out and my husband has poor eyesight and balance. On the 'normal' roads, there is a lot of traffic and no sidewalks, and if so, they are too small. It would be more convenient if there were more paved paths [in the wood]"*. However, most participants considered green spaces (as woods, parks, and gardens) as opportunities for RW, providing a sense of naturalness and peace. The lack of green spaces within walking distance was mentioned by participants without a car. The inconvenience of public transport was also mentioned in this context and will be discussed later. Furthermore, the lack of cleanliness associated with the absence of dustbins in public spaces was mentioned as a barrier for enjoyment during RW. However, some participants mentioned walks to collect dirt. The poor or absence of street lighting was perceived a barrier for RW after dark. A 54-year-old woman described: *"Very disturbing in our street is that there are no lights, it is completely dark at night. The ground isn't exactly flat either and there are a lot of strange people around, that you don't want to run into"*. Heavy traffic, high speeds, the lack of traffic lights, speed bumps or speed cameras are also considered important impeding factors for RW related to traffic safety. The presence of public toilets, benches, parking, off-leash zones for dogs and side-activities (especially for children) were considered important facilities to enable RW. A 58-year-old woman explained: *"I always organize myself so I can go [to the toilet] somewhere. I also take medication to anticipate having to go to the toilet. But that is of course not advised. It is a big additional stressor. There are some facilities, mostly restaurants or a bar, but people don't always allow you to go."* Furthermore, parks and art were seen as stimulating destinations for RW. While vacant stores, weather conditions (e.g., rain or hot temperatures) and pollution (e.g., noise and car fumes) were perceived as impediments to RW.

3.2.2. Perceived sociocultural environment

Themes in the sociocultural environment involve social safety, social involvement, social support, work-life integration, sociocultural standards, and modeling.

Social safety consists of barriers to RW due to perceived crime and drugs, unattended dogs, the presence of 'gangs', racism and discrimination, stigmatism, gender aspects, and driving behavior. Multiple participants mentioned that drug and alcohol addiction is prevalent in their neighborhood and that this contributes to feelings of insecurity, especially at night. However, they emphasized that they do not feel unsafe in the municipality or perceive a lot of crime. There are no 'real

gangs', but some participants stated that people hanging out at night scares people: *"The hanging together, it scares people. You have a Romanian shop, people hang out there, on the East side you also have a petrol station where people congregate. It might discourage people to pass by, or even go outside. (man, 55)"*. Unattended dogs were discussed as a barrier: *"I have been attacked by a stray dog of someone who claims: 'my dog obeys', it is very frightening when you are attacked by a hunting dog, that's really a barrier for me not to go alone into the wood (woman, 60)"*. Other barriers are racism and stigmatism. Perceived racism was explained by some participants as stories about people yelling or talking differently because of their skin color, people staring at them, not being friendly or ignoring greetings. Stigmatization because of unemployment and mental or physical vulnerability was also described: *"I dare not join a walking group or something similar because people don't understand my situation. They ask what I do for work and I cannot answer. I immediately feel different and excluded. I know that part of this is also self-stigmatization, but there is a lot of stigma around mental illness. You are immediately labelled dangerous, strange, and crazy" (man, 55)*. Gender aspects also play a role in RW. Some participants indicated that as a single woman they avoid certain places (e.g., walking alone in the wood, especially in winter or after dark). Some male participants also indicated that they don't like their daughters to be out alone. Finally, driving behavior (mostly driving too fast) is also seen as a barrier.

Interaction with the community, place attachment, and socio-political engagement are part of the category 'social involvement'. Friendly social interactions (e.g., greetings, smiles, small conversations) are an important facilitator for RW for many participants. However, for some participants with bad experiences (e.g., people ignoring them) these interactions function as a barrier. Place attachment also emerged as a facilitator, referring to a sense of attachment or feeling of belonging that people experience towards their environment. Some participants specifically chose their housing location for the nature or walking opportunities nearby. Socio-political engagement is discussed in the section on the political environment.

Social support consists of social relationships, social isolation, and dog-ownership. Multiple participants mentioned partner, children, and friends as facilitators. They mentioned that RW facilitates dialogue and discussions (*"walking makes the brain move"* – woman, 44) and parents wanting to set a good example for their children ('modeling'). One participant mentioned how a fluorescent jacket and a pick pole (provided by the school) motivated him and his son to walk and simultaneously clean up the dirt. However, group walks were perceived as a barrier due to the lack of a sense of belonging, meaning that participants did not identify with other participants and alignment of the walking group in terms of personal ability (e.g., speed and distance). A 58-year-old woman wanted to join a walking group, but the only group she could participate in (due to distance and speed) was an organized walk by the older people association: *"I participated once, and I really fell out completely. I thought 'I'm not that old'. There was no connection, they were much on their own, already knew each other"* Another male participant of 64 with a physical impairment testified: *"I have tried a few times with a group of dog walkers. After 10 m I couldn't follow anymore, and I had to say 'bye-bye' (...) There is a walking club, but I can't join because I'm half disabled. They should do something for those who can still walk a bit, to get them walking as well."* Social isolation is mentioned as a barrier: *"I used to enjoy being alone during a walk. But now I've been alone so much that I really don't feel like to go out alone anymore. I want to talk and do things. I have this need for social interaction, but it is very difficult to have real contact with people (woman, 58)." In some cases, participants enjoyed walking alone to clear their mind, to enjoy nature in peace or to relieve stress, however this is considered 'deliberate social isolation'. In addition, dog-ownership is an important facilitator for RW for many participants. The guilt of keeping the dog indoors and the fact that dogs facilitate social interactions with community members were cited as important factors.*

Work-life integration was mentioned as a barrier and refers to a lack

of time for RW in relation to long working days, inflexible working hours, household tasks and childcare. Sociocultural aesthetics, cultural aspects of recreation and car culture are part of the theme 'cultural standards'. Sociocultural aesthetics refers to aspects of the physical environment associated with emotions. Participants indicated that they like to visit places, reminding them of the past, e.g., places they visited with their children, that remind them of places they once lived. Cultural aspects of recreation refer to the meaning participants attach to RW. Some participants with a non-Belgian nationality mentioned that RW is not really part of their culture. To other participants RW is important to learn basic things about nature and respect (e.g., "don't damage trees or if you drop paper, pick it up" - woman, 45). Finally, car culture was also mentioned as a barrier. Some participants called it a direct barrier ("the car made us lazy" - woman, 28) or as an indirect barrier because there is too much traffic in the area.

3.2.3. Perceived economic environment

Themes in the economic environment include affordability, lack of funds, public recreation and transport investments, the use of incentives and the availability of low-cost RW activities.

Walking is often seen as free of charge ("walking is cheap, it is the only thing you can still get for free" - man, 60). However, many participants pointed out direct and indirect connections with affordability. Firstly, they emphasized that walking is cheap, but if you want to take longer hikes or trips into the fields or woods, good shoes are required. Some participants only stay on paved roads because they are afraid that their only pair of shoes will get dirty or wet. This was especially the case in Herselt, which is surrounded by woods and specific footwear is often necessary in a rainy country like Belgium. Secondly, costs related to social interactions (e.g., going for a drink after walking), digital necessities (e.g., online walking maps require a smartphone with mobile data) or medical needs (e.g., physiotherapist) were mentioned. A 62-year-old female participant testified: "Exercise is not possible for me financially. I should see a physiotherapist to help loosen up my muscles, but I can't afford that (...) Everyone wants me to get out and move more, but it must be OK financially." Thirdly, participants also indicated the 'mental and time affordability', meaning that RW is not a priority and that there are other basic needs that must be met first. A 41-year-old woman explained: "Due to corona we only got 70% of our pay, we were not able to make ends meet, I was panicking. Walking was not at all important for me."

There is a perceived lack of funds in the municipality for public recreational investments (such as maintenance of public spaces or infrastructure investments): "those paving stones are damaged, but when you inform the municipality, they say 'we know, but there is no budget' (woman, 58)." There is also a perceived lack of investment in public transport: "I think the cost is too much for what comes in (...) It is a domino effect. They provide less transport, so you hardly use it. Then the bus gets more expensive, so they're going to spread them [bus time schedule] even more hours (man, 45)."

The availability of low-cost walking activities is perceived as a facilitator. Participants gave examples of organized group activities with fees based on income or flexible payment options (e.g., bi-monthly payment instead of monthly). The availability of free walking maps with written explanations was also perceived as beneficial. Incentives (vouchers or food) are also perceived as facilitating (e.g., food-store voucher for the winning team after a photo quest).

3.2.4. Perceived political environment

Perceived political environmental factors include public recreation and transport regulations, local government support, and socio-political engagement.

Our findings reveal that the political environment is linked to all other environments. Public recreation regulations impact the physical environment through urban planning (e.g., creation of recreational public spaces), maintenance (e.g., streets and green spaces) and cleanliness (e.g., multiple participants emphasize trash and the lack of trash

cans being a barrier - the removal of dustbins was a local government decision aimed at reducing trash). Public transport regulations are perceived to be inadequate (limited availability and poor connections), which makes it difficult for participants to access parks or woods further from home or to meet up with people for a walk.

Furthermore, local government decides on public recreation investments. Participants pointed out that priorities are often placed on 'self-advertisement' (e.g., "They [the local government] installed a bicycle counter on the bridge. It will be a nice picture and maybe an article in the newspaper, but it won't solve the heavy traffic problem and the security issues for pedestrians that need to cross this bridge" - woman, 58), in central locations rather than decentralized areas (e.g., the local sports center), and that public planning places too much emphasis on the 'general' population (i.e., to the 'healthy' middle class population) at the expense of more vulnerable groups.

The possibilities for socio-political engagement (e.g., volunteering, or civic engagement for PSEDS) are perceived as insufficient. Some participants want to be more involved in their municipality. They feel that there are few opportunities to express their needs, including needs related to public space and walking options: "I am written off to make a difference. If you cannot walk 2 km, you can't get to the town hall and knock on the table (man, 64)." The (in)accessibility of governmental structures (e.g., inflexible opening hours, non-reactivity to questions, digital gap) is perceived as a barrier to expressing their needs and collecting information related to public places. The complex and rigid structures of the local government (e.g., rigid language and communication policy, lack of inter-departmental and inter-organizational communication and coordination) are perceived as inefficient and not inviting. Besides, participants felt that the local government does not always know what is going on in the community or what is important (e.g., "They wanted to make something different here, but I signed against it. The municipality does not realize that there are many lonely people or older couples, that like to come here [for a walk], to see animals, watch birds and go to the pond. This is actually an important place, but they don't realize it" - woman, 62). In addition, there is a lack of government support for local initiatives that stimulate RW (e.g., "Such things are stimulating [reference to a woman who organizes walking quests for children and gives an incentive at the end]. Why not give this woman some support? They should put her in the spotlight. She does it for free and in her spare time." - woman, 30).

3.2.5. Perceived information environment

Participants talked about barriers to disseminating, finding, and understanding information. Therefore, they suggested adding the information environment as an environmental type in the ANGELO framework, as they felt that these themes did not fit with any of the environments previously discussed.

Participants emphasized the significance of available and accessible information and its impact on walking activities. Many participants expressed a lack of awareness regarding available walking opportunities within their municipality and struggled to find relevant information. Difficulties in accessing online information were highlighted as a barrier. A 52-year-old man said: "I have no idea where I could go. You can look up information on the computer, but that's a lot of hassle and my options are limited. (...) People who are alone or have problems usually don't have the energy to figure it all out." Furthermore, the lack of promotion for walking routes or insufficient information on signs and maps was also an important barrier. In addition, some participants mentioned that it often takes a smartphone or mobile data to access QR-codes with a link to online maps and added that they had difficulty using a smartphone or that they could not afford mobile data. Some participants indicated that they prefer communication of activities through social media such as Facebook, while others preferred traditional media such as the municipality journal.

Understanding of information was also considered a challenge. Some participants explained having difficulty with orientation and were afraid of getting lost. Some mentioned they liked the hiking nodes (a common

system in Belgium), while others found it difficult to connect the different nodes, or to read (online) maps. Routes that have already been developed and printed on leaflets with detailed information about the route provided for free were mentioned as a facilitator. Furthermore, some participants with a non-Belgian nationality mentioned language barriers, as all official governmental communication (e.g., municipality journal or website) in Flanders is in Dutch.

4. Discussion

This paper contributes to the literature on the understudied group of PSEDS in peri-urban areas by exploring perceived environmental factors that play a role in their RW behavior. The participatory approach, through walk-along interviews and focus groups, revealed detailed and context-specific insights into the different environmental factors important for RW.

In what follows, we will first elaborate on the different types of local environments that are important for PSEDS in a peri-urban environment. Secondly, we will discuss the perceived environmental factors that have a role in RW specifically for PSEDS. Thirdly, we will explore the perceived environmental factors that are specific for a peri-urban environment.

4.1. Types of environments that play a role in RW among PSEDS in a peri-urban environment

Our study aimed to explore the perceived environmental factors affecting RW among PSEDS residing in peri-urban areas. Using the ANGELO framework, we categorized the perceived environmental factors into four environmental types (physical, sociocultural, economic, and political) through a deductive approach. The framework effectively facilitated the categorization of perceived environmental factors affecting RW among PSEDS in a peri-urban environment. However, two notable findings regarding the framework emerged.

A first finding is that our participants explicitly added 'information environment' to the framework. They identified information transfer and the digital environment as environmental features with an increasing importance in this 'modern' world. However, information as part of a socioecological framework is not new. Sallis et al. (2006) suggested in their ecological model of four domains of active living that information is present in all behavior and policy settings, including counseling in health care settings, sports-related information, and setting-specific information sources. Our participants indicated that information should be available and easily accessible, with explicit attention for the digital barrier that many of them experience and the diversity within the target group towards the concept of 'easy access'. Previous research suggests that digital exclusion primarily affects socioeconomically disadvantaged and vulnerable groups in more rural areas (Park et al., 2019). Future research should consider the role of the digital (information) environment in health behavior inequalities and digital interventions aimed at improving PA must consider the needs of PSEDS.

A second finding is that different environmental types interact and are embedded. There are overlapping themes in multiple environments, as already confirmed in previous literature (e.g., Belon et al., 2014; Sallis et al., 2006; Van Dyck et al., 2014). Several examples from our study highlight this finding. For instance, safety has both a physical (e.g., lighting, safe crossings, traffic safety and speed) and a social (e.g., crime, drugs, dogs, stigmatization and driving behavior) dimension. Another example is accessibility, which encompasses physical accessibility (e.g., maintained sidewalks and paved roads), but may also refer to information accessibility (e.g., digital literacy), political accessibility (e.g., regulations on maintenance of sidewalks, accessible communication, or allocation of resources towards public spaces), economic accessibility (e.g., affordability to access) and sociocultural accessibility (e.g., social accessibility). Political and economic factors are perceived to be

intertwined with the other environmental factors in a more dominant way. The perceived lack of political decisions regarding urban planning and investments in public recreational infrastructures and public transport affects other domains such as maintenance, cleanliness, social interactions, low-cost and accessible walking activities. This demonstrates that people's use and interaction with the physical environment cannot be separated from the sociocultural, economic, political and information environment (Belon et al., 2014).

4.2. Environmental factors that affect RW specifically for PSEDS

Multiple perceived environmental factors affecting RW among PSEDS are similar to findings for the general population. Examples are the role of proximity and access to green spaces, safety from traffic and crime, social support and dog-ownership in RW (e.g., Chaix et al., 2014; Cutt et al., 2008; Sugiyama et al., 2014). Despite the distinct overlap, there are important differences specifically linked to this group. First, socioeconomic disadvantage is a multi-layered issue and PSEDS are not a homogenous group of people (Evans, 2019). This illustrates the importance of individual characteristics and how these interact with perceptions and uses of the local environment (Feuillet et al., 2016; Franke et al., 2019). Despite the heterogeneity of PSEDS, there are mutual issues to consider. Our findings show that PSEDS suffer worse health and more functional limitations, which makes physical accessibility (e.g. presence and maintenance of sidewalks, paved roads, lighting, benches, public toilets) a more important issue compared to the general population. Some studies suggest that these perceived enabling factors are more absent in socioeconomically disadvantaged neighborhoods (Sugiyama et al., 2015). Moreover, these health issues and functional limitations were also linked to difficulties PSEDS experienced with covering longer distances and speed which was connected to barriers to participate in group, feelings of unsafety and perceived stigmatization. Other examples are the mental affordability due to household and family tasks; or (digital) illiteracy and perceived barriers to information. Rawal et al. (2020) also state that besides socioeconomic factors, culture, gender, disability, and diverse sociodemographic factors intersect to impact movement opportunities in different contexts.

Second, RW is often seen as accessible and affordable for everyone, as it is free of budget, easy and convenient (Kelly et al., 2017). However, indirect costs related to walking, such as proper shoes and rain protection, availability of (public) transport, social cost (e.g., drinks afterwards) and medical costs (e.g., physiotherapist) undermine this statement. Moreover, a systematic review on PA among PSEDS confirms our findings that both financial affordability and mental and physical energy are prioritized for work, school, household tasks and family responsibilities (Rawal et al., 2020).

Third, the role of the sociocultural environment on RW has previously mostly been measured quantitatively and focused on concepts as social support, safety, social cohesion and social norms (Caspi et al., 2013; Iroz-Elardo et al., 2021; Sawyer et al., 2017; Van Cauwenberg et al., 2014; Van Holle et al., 2016). PSEDS often reported physical and social isolation as an important barrier for RW. Our results indicate that this is due to their often physically isolated living location, the structural inaccessibility they experienced with public transport and a lack of alternative and affordable transport options, the structural inaccessibility towards information, and a lack of opportunities to broaden and reinforce a social network without the experience of stigmatization, racism, and shame about their financial and work-situation. Limited transport opportunities, inaccessibility of infrastructures and challenges regarding social mobility have been previously found to be specific for peri-urban areas (Camarero & Oliva, 2019; Rijsbosch, 2016). A recent study of Algren et al. (2020) showed that residents of deprived neighborhoods had higher odds of loneliness and social isolation, which was significantly associated with higher odds of health-risk behavior (e.g., physical inactivity and unhealthy eating). Even stronger associations were found in combination with an individual low economic status

(Algren et al., 2020).

4.3. Specificities to peri-urban environments

Most perceived environmental factors, in particular the built environment features, affecting RW are similar to those in urban areas. However, there are distinct differences between urban and peri-urban areas which might make transferability of findings and interventions in particular difficult. First, we noticed that there were no civil society organizations (CSO's) (e.g., non-governmental aid organizations or poverty organizations) in both municipalities, which is different from urban areas where often multiple and diverse CSO's are available (Van Gyes et al., 2018). This might have an impact on community interactions, the degree of social isolation, the lack of sociopolitical engagement, a sense of belonging and information transfer to vulnerable groups (Van Gyes et al., 2018). Secondly, mobility poverty is a growing issue in peri-urban areas (Camarero & Oliva, 2019; Rijsbosch, 2016). A perceived lack of and low quality of public transport (i.e., no frequent services, limited served districts, no connections between sub-municipalities) and a lack of alternative transport options (e.g., car or bike sharing system) discouraged RW further away from home among participants. Fan et al. (2017) suggested in their research that the lack of public transportation options in rural areas could be the result of low population density rendering the development of public transportation infrastructure cost-ineffective. Urban areas are known for frequent public transport connections and often provide alternative transport options (Fransen et al., 2015). Moreover, PSEDS generally have less opportunities to choose where they want to live (i.e., social housing and affordability) (Brisson et al., 2018). Therefore, mobility poverty contributes to both physical and social isolation. Public transport is most of the time linked to walking for transport and less with RW (Cerin et al., 2022). However, previous studies on outdoor recreation and recreational PA also mentioned the transport-related constraints (Ghimire et al., 2014). Thirdly, compared to urban areas there are more green spaces present in peri-urban areas. However, these tend to be of a more natural nature (e.g., woods and fields) and less centralized (e.g., woods around the municipality, but not always easy to reach) compared to constructed and centralized parks in urban areas (Wolff et al., 2020). Green spaces are found to be important facilitators for RW for aesthetic and social interaction reasons and might have potential to improve health equity (Rigolon et al., 2021). Therefore, focus should shift more to accessibility in use of these green spaces (e.g., through well-maintained and paved paths, accessible information and signposted trails, inclusive public transport, adapted walking groups). Fourthly, as already mentioned above, PSEDS suffer worse health and functional limitations, which is why access to benches and toilets among others are perceived important. However, cafes and restaurants or other public facilities that could serve as an alternative are sparsely seeded in peri-urban areas.

4.4. Strengths and limitations

This study has certain limitations to consider. First, there may be a self-selection bias among participants, as those who agreed to participate might be more physically active, mobile or more interested in RW compared to persons who declined participation. Additionally, the walk-along interviews took place in the wake of the Covid-19 pandemic. This influenced the recruitment process (as some potential participants were hesitant to participate out of fear for contamination) and may have affected the results (as some participants were more or less active compared to 'normal' periods). Finally, this study focused on PSEDS based on educational status, work status, perceived SES, and perceived income. However, this is not a homogeneous group of people and there are distinct challenges. Although perceived racism was identified in the results, the sociodemographic questionnaire did not include data on race and ethnicity, making it difficult to draw conclusive findings. Future

studies should carefully consider the role of factors such as race, ethnicity, gender, mental and physical disabilities, social housing or single parenthood in relation with environmental perceptions.

This study has various strengths. First, the walk-along data provide a comprehensive understanding of the relation between participants' walking behavior and their local environment by offering insights into their perceptions, experiences and interactions. Unlike closed-question surveys that may overlook relevant environmental features and nuances in understanding people's walking behavior, the qualitative methodology employed in this study yields in-depth and richer information, capturing interactions between the different environments (Carpiano, 2009). Second, the study examines multiple environments rather than focusing on a single environment, enabling the identification of interconnections among them. Third, this study focuses on RW among PSEDS in a peri-urban environment through a community-based approach, while previous research mostly focused on urban environments and the general adult population. Fourth, few studies investigated cultural aspects in RW, despite the potential influence of different cultural backgrounds on people's perception and use of the environment. Future research should delve into this aspect and adopt an intersectionality approach encompassing race, ethnicity and gender. Lastly, the participant-driven nature of the data allows the participants to guide researchers towards the local environmental features that are most important and relevant to them (Jull et al., 2017).

5. Conclusion

This study illustrates that peri-urban environments offer specific challenges for RW among PSEDS. A broad understanding of the contextual factors and the various dimensions of the local environment is crucial for comprehending the mechanisms affecting RW among PSEDS and the interconnectedness of different environmental types. The ANGELO framework has proven valuable in analyzing and categorizing perceived environmental factors affecting RW among PSEDS in peri-urban areas. Additionally, participants emphasized the significance of the information environment, particularly the digital environment. Despite the heterogeneity of PSEDS, this study revealed their reliance on the immediate environment for RW and identified distinct features in the perceived environment that affect RW in peri-urban areas. Moreover, this study underscores the significance of individual characteristics and their interaction with perceptions and use of the local environment. Future research is needed to explore how to co-create supportive environments that have the potential to promote RW among PSEDS in a peri-urban setting.

Author contributions

SuD* (female, previous experience in conducting interviews) performed the walk-along interviews. There was no relationship prior to study commencement and the interviewer was not connected to both municipalities. SuD* conducted the focus groups while YI assisted. SD provided regular feedback during the interview and writing phase. All co-authors provided feedback to the coding tree. SuD* is responsible for drafting the article. All co-authors reviewed draft versions of the manuscript and approved the final version for publication.

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Declaration of interest

None.

Ethical Statement for Solid State Ionics

Hereby, I, Suzannah D'Hooghe, consciously assure that for the manuscript 'the role of the perceived environment for recreational walking among adults in socioeconomically disadvantaged situations: a study using walk-along interviews' the following is fulfilled:

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
- 2) The paper is not currently being considered for publication elsewhere.
- 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
- 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
- 5) The results are appropriately placed in the context of prior and existing research.
- 6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
- 7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

The violation of the Ethical Statement rules may result in severe consequences.

To verify originality, your article may be checked by the originality detection software iThenticate. See also <http://www.elsevier.com/editors/plagdetect>.

I agree with the above statements and declare that this submission follows the policies of Solid State Ionics as outlined in the Guide for Authors and in the Ethical Statement.

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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

Data will be made available on request.

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Appendix A. Supplementary data

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