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Barriers and facilitators impacting the experiences of adults participating in an internet-facilitated pedometer intervention

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ABSTRACT

Objectives: Internet-facilitated physical activity interventions are becoming more common. A better understanding about the barriers and facilitators experienced by participants is needed to improve the delivery and effectiveness of these types of interventions. Our study explored perceived individual, social, and physical environment characteristics that hinder or facilitate physical activity among previously "inactive" adults during a 12-week internet-facilitated pedometer intervention.

Design: Qualitative Study (qualitative description).

Method: Twenty-three participants (82.6% women; ages 24–68 years) who registered for the 12-week internet-facilitated pedometer intervention (UWALK) participated in telephone-administered semi-structured interviews. Interview questions explored perceived barriers and facilitators to physical activity during the UWALK intervention. Participants were purposefully sampled to represent various levels of engagement with UWALK.

Results: The experiences shared by participants were represented by four themes including: creating (in)activity awareness; commitment to physical activity; incorporating activity for transportation, and; importance of nature and changing scenery. Wearing the pedometer and recording their daily steps made participants more aware about time being sedentary. Moreover, participants developed strategies to help achieve their step goals. Active transportation was frequently mentioned as an effective way of increasing daily steps, and access to nature or beautiful scenery encouraged more physical activity.

Conclusions: Perceived individual and environmental factors contribute to participants' ability to engage in UWALK and physical activity. Providing participants enrolled in internet-facilitated pedometer interventions with strategies for overcoming barriers, instructions for exploring their local environments, and approaches for incorporating active transportation into daily routines, may improve adherence and, ultimately, increase physical activity.

1. Background

Pedometers are inexpensive and simple-to-use devices for motivating and monitoring physical activity, especially in population and community interventions (Bravata et al., 2007; Silfee et al., 2018). They are used as a tool for motivating physical activity in interventions and have the potential to improve health (Tudor-Locke et al., 2011). Adults achieving ≥10,000 pedometer steps per day are more likely to achieve recommended levels of physical activity (Le-Masurier, Sidman, & Corbin, 2003; McCormack, Giles-Corti, & Milligan, 2006) as well as experience improvement in bodyweight (Schneider, Bassett, Thompson, Pronk, & Bielak, 2006), blood pressure (Swartz et al., 2003; Tully & Cupples, 2011), and glucose tolerance (Swartz et al., 2003). Participation in pedometer-facilitated physical activity interventions is associated with improved weight status among overweight and obese adults with (Cai et al., 2016) and without (Richardson et al., 2008), type II diabetes, reduced resting heart rate among sedentary workers (Chan, Ryan, & Tudor-Locke, 2004), reduced systolic blood pressure (Bravata et al., 2007), improved positive affect (Baker et al., 2008), and improved physical function and decreased pain and disability among those with musculoskeletal disorders (Mansi, Milosavljevic, Baxter, Tumilty, & Hendrick, 2014).

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Results from pedometer-based interventions for promoting physical activity are encouraging (Bravata et al., 2007; Kang, Marshall, Barreira, & Lee, 2009; Mansi et al., 2014; Wallmann, Spittaels, De Bourdeaudhuij, & Froboese, 2011). Adults enrolled in pedometer interventions lasting 4–5 months are found, on average, to have a 29% increase in their pedometer-counted steps (Bravata et al., 2007). Pedometer interventions combined with goal-setting strategies are also beneficial, with increases in physical activity up to 2500 steps per day reported (Bravata et al., 2007; Ogilvie et al., 2007). Self-monitoring of daily steps is a major component of internet-facilitated (e.g., Jennings et al., 2017), and non-internet facilitated (e.g., Chan & Tudor-Locke, 2008; Heesch, Dinger, McClary, & Rice, 2005; Shaw et al., 2011) pedometer interventions. Internet-facilitated pedometer interventions are one of several eHealth approaches used to promote improvements in physical activity (Müller, Alley, Schoeppe, & Vandelanotte, 2016; Norman et al., 2007). Such interventions can include communication of heath information (e.g., delivery or messages or behavioral feedback), interaction between the participant and the technology, and behavioral monitoring via the internet (Müller et al., 2016; Norman et al., 2007). The pathways by which pedometer use might result in higher physical activity aligns with several behavior change theories such as control theory (Carver & Scheier, 1982) and social cognitive theory (Bandura, 1986; Spence, Burgess, Rodgers, & Murray, 2009). These theories recognize that self-monitoring leads to self-evaluation and feedback of progress towards a specific goal, and that this feedback can lead to behavior modifications to achieve a specific goal as well as reinforce the monitored behavior. Notably, qualitative evidence suggests that pedometers encourage physical activity via the instantaneous feedback provided to the wearer. This feedback allows physical activity to be modified to reach step goals and increases the wearers conscious awareness regarding their own steps (shown by the pedometer step count) and about their own physical activity levels (Gardner & Campagna, 2011; Heesch et al., 2005; Jones, Richeson, Croteau, & Farmer, 2009; Shaw et al., 2011; Thorup et al., 2016). The requirement to regularly record, submit, or share step progress with others and a sense of accountability to family, friends, and sometimes researchers or program staff can also encourage higher adherence and physical activity among pedometer intervention participants (Gardner & Campagna, 2011; Heesch et al., 2005; Jones et al., 2009; Shaw et al., 2011; Thorup et al., 2016). However, contextual factors might also modify the impact of pedometer interventions for improving physical activity.

Pedometer interventions may encourage physical activity even in unsupportive situations such as during poor weather or encountering a low walkable environment. Seasonal patterns in pedometer-based physical activity have been observed among clinical (Dasgupta et al., 2010) and non-clinical populations (Clemes, Hamilton, & Griffiths, 2011; Hamilton, Clemes, & Griffiths, 2008; Tudor-Locke et al., 2004), and poor weather can negatively impact participation in pedometer interventions (Heesch et al., 2005; Jones et al., 2009; Shaw et al., 2011). Elsewhere, however, participants in pedometer interventions report maintaining their physical activity during inclement weather by substituting usual outdoor activity locations for indoor activity locations (e.g., malls, supermarkets, and home) or by modifying their physical activity (e.g., undertaking housework instead of walking) (Jones et al., 2009).

Participation in pedometer interventions may change how individuals perceive their built environment. Participants of pedometer interventions have been found to perceive shorter distances to local facilities, higher availability of bike infrastructure, better networks, and safer traffic conditions (Wallmann et al., 2011), and reported increased awareness of features in their local communities (Shaw et al., 2011). Jones et al. (2009) found that among older adults in a pedometer intervention, walking in traffic-congested areas, the presence of skateboarders, bicyclists, and cars, fear of dogs and wildlife, and slippery walking surfaces due to snow and ice were safety concerns hindering their daily steps. Others studies have higher pedometer steps among adults residing in more physical activity supportive neighborhood built environments (i.e., higher walkability) (Dygryn, Mitas, & Stelzer, 2010; Van Dyck, Deforche, Cardon, & De Bourdeaudhuij, 2009).

The relation between the built environment and pedometer-measured physical activity is not surprising given quantitative (Duncan, Spence, & Mummery, 2005; Ferdinand, Sen, Rahurkar, Engler, & Menachemi, 2012; McCormack & Shiell, 2011) and qualitative (McCormack, Rock, Toohey, & Hignell, 2010; Salvo, Lashewicz, Doyle-Baker, & McCormack, 2018) evidence suggesting the built environment is important for supporting physical activity and, in particular, walking. Thus, for participants in pedometer interventions, the potential exists for the neighborhood built environment to enable or even restrict intervention engagement and physical activity. Socioecological models posit that an individual's behavior is the product of many interacting factors at multiple levels (e.g., intra-individual, inter-individual, physical environment, policy, culture) (McLeroy, Bibeau, Steckler, & Glanz, 1988; Spence & Lee, 2003; Stokols, 1992). The socioecological model is commonly used to inform studies investigating the environmental correlates of physical activity (Sallis et al., 2006; Spence & Lee, 2003). But, investigation into how these factors, the built environment in particular, might contribute to an individual's decision-making in relation to initiation, adherence, and participation in internet-facilitated pedometer interventions is lacking. This evidence could be particularly useful for informing urban and transportation planning and policy as well as health promotion programing and interventions. Furthermore, studies estimating the built environment effects on physical activity interventions in general report mixed findings, with perceptions of the built environment seemingly more consistently impacting the effectiveness of interventions than the actual ("objective") built environment (Gebel, Bauman, Reger-Nash, & Leyden, 2011; Kerr et al., 2010; King et al., 2006). Thus a better understanding about the built environment as well as social and individual barriers and facilitators experienced by participants is needed to improve intervention delivery and effectiveness (Davies, Spence, Vandelanotte, Caperchione, & Mummery, 2012).

The purpose of our qualitative study was to explore individual, social, and physical environment characteristics that hinder or facilitate physical activity among previously "inactive" adults during a 12-week community-based internet-facilitated pedometer intervention. This research was informed by ontological relativism (accepting multiple mind-dependent realities) and epistemological constructivism (believing that knowledge of reality is constructed through subjective experiences). Specifically, our assumption is that humans perceive (or subjectively construct) the physical environment along with other external and intrinsic factors, which limits and or supports their attempts to undertake healthy behavior (i.e., trying to participate in a community-based physical activity intervention).

2. Methods

2.1. Study approach

Qualitative description, as described by Sandelowski (2000), was the method used to guide this study. This method supports the exploration of research questions using plain or "everyday language", and results in a comprehensive summary of experiences (Sandelowski, 2000). Unlike other qualitative methods (e.g., grounded theory) that transform findings, qualitative description is described as "data near" (Sandelowski, 2010). But, such proximity to the data does not mean this method lacks depth; it is frequently applied in situations where little is known about a phenomenon, event, or context and, therefore, a depth of data is desired (Sandelowski, 2000). Qualitative description, as a method, is varied in that it is not characterized by one specific process of data generation or data analysis (Sandelowski, 2010). However, given that qualitative description studies are focused on providing a

comprehensive summary of experiences, data generation within this method typically occurs through one-on-one interviews (Sandelowski, 2000). As well, content analysis is an optimal approach for qualitative description studies, as this dynamic form of analysis supports the summarization of information (Sandelowski, 2000). Various other studies in sport and exercise psychology (e.g., Barnett, Guell, & Ogilvie, 2013; Larson, McFadden, McHugh, Berry, & Rodgers, 2018) have described how one-on-one interviews and content analysis were central to the success of their qualitative description method. In the case of this study, neighborhood built environment is unique to each participant depending on their residential location, and detailed feedback was desired with regard to participants' experiences with daily walking in their own individual living environments. The qualitative description approach allowed for the elicitation of comprehensive descriptions of neighborhood characteristics as well as the facilitators and barriers experienced in participants' attempts to engage in the intervention (i.e., UWALK program). The Conjoint Health Research Ethics Board (CHREB; University of Calgary) approved the study; REB15-2944).

2.2. Participants

Twenty-three adults (82.6% women; ages 24–68 years) who registered for the 12-week UWALK program were purposefully selected to be interviewed (Table 1). They were part of a larger sample (N = 499) of inactive adults (at least 18 years of age) with no mobility limitations and living in Calgary (Alberta, Canada), who had self-selected to participate in UWALK between April 2016 and 2017 (results forthcoming). We selected individuals based on their date of enrollment in the study (in chronological order) and invited them to participate in the interviews via email. Using date of enrollment to recruit individuals resulted in a heterogeneous sample in terms of sex, age, education, pedometer steps, number of days steps entered, behavioral intentions, self-efficacy, and neighborhood walkability (Table 1). Note that a structured baseline telephone interview captured participant's sociodemographic characteristics and cognitions at their entry into the intervention, pedometer data were extracted from participant's reported steps on the UWALK website, and Walk Score® is a publicly available walkability index available for most Canadian 6-digit postal codes (thus allowing Walk Score® to be linked with participant households). This recruitment strategy allowed us to explore the barriers and facilitators at different stages of the physical activity decision-making process and levels of engagement in UWALK (as defined by their entry of steps in the website).

2.3. Internet-facilitated pedometer intervention (UWALK)

UWALK is informed by a prior internet-facilitated pedometer intervention undertaken in Queensland (Australia) that was successful in increasing physical activity in adults (Brown, Mummery, Eakin, & Schofield, 2006; C. Davies et al., 2012; Mummery, Schofield, Hinchliffe, Joyner, & Brown, 2006). The UWALK intervention uses simple but established health promotion approaches (informed by social cognitive theory) for empowering individuals to walk as a means of increasing their physical activity, including achieving 10,000 steps/day (Jennings et al., 2017). Participants self-monitor their physical activity using pedometers and manually upload their steps to the UWALK website (http://uwalk.ca). UWALK encourages participants to self-monitor their steps and progress, undertake individual and group challenges, and receive feedback and advice to assist them in increasing steps and physical activity (Jennings et al., 2017). UWALK recommends that participants purchase or borrow their own pedometer or other tracking device however, in the current study all participants received a pedometer.

2.4. Data generation

Data were generated via one-on-one semi-structured telephone interviews conducted between November 2016 and February 2017. Individual interviews were deemed the most appropriate method for this qualitative description study due to their effectiveness in eliciting rich data about personal experiences (Sandelowski, 2000); telephone interviews were used for participant convenience. Telephone calls were audio recorded and the interviewer took notes throughout each interview. To recognize their time, participants received a $25 gift card.

Table 1
Characteristics of participants completing qualitative interviews (n = 23).

Pseudonym	Sex	Age (years)	Education	Occupation	Walkability[a]	Confidence[b]	Intention[c]	Days steps recorded[d]	Mean steps per day
Barbara	F	61	College/trade	Unemployed	39	5	5	79	5501
Madeline	F	66	Postgraduate	Retired	43	6	6	80	13,698
Karen	F	38	College/trade	Management/admin.	12	5	6	83	6752
Julie	F	31	College/trade	Unemployed	57	5	6	78	8685
Steve	M	34	College/trade	Professional	37	7	7	79	9845
Elizabeth	F	46	Undergraduate	Professional	17	6	7	85	5594
Luke	M	21	High school or less	Unemployed	41	6	7	70	7116
Frank	M	55	Postgraduate	Retired	78	7	7	83	12,050
Rachel	F	66	Undergraduate	Retired	29	7	6	83	13,029
Victoria	F	66	Undergraduate	Retired	17	5	6	25	7620
Emma	F	54	Undergraduate	Professional	76	6	7	6	8157
Tammy	F	63	Undergraduate	Retired	53	5	6	80	11,289
David	M	52	Undergraduate	Management/admin.	20	7	7	39	7375
Grace	F	68	College/trade	Retired	30	4	5	67	12,867
Sarah	F	36	Undergraduate	Unemployed	32	6	6	42	3252
Pamela	F	56	Undergraduate	Professional	4	6	7	79	10,508
Abigail	F	51	Undergraduate	Management/admin.	63	3	1	63	10,096
Nancy	F	64	College/trade	Management/admin.	84	6	7	23	6110
Olivia	F	21	High school or less	Unemployed	51	7	5	0	0
Wendy	F	68	High school or less	Retired	33	6	6	37	11,316
Hannah	F	29	Undergraduate	Professional	81	1	2	62	159
Caroline	F	24	Undergraduate	Professional	21	4	4	85	6545
Isabelle	F	54	Undergraduate	Clerk/service/sales	83	7	7	49	13,470

[a] Estimated using Walk Score® at participants household address.
[b] Higher score reflect higher confidence to achieve 10,000 steps/day: *"Not at all confident"* (1) to *"Completely confidence"* (7).
[c] Higher score reflects higher intention to participation in 10,000 steps/day: *"Definitely do not intend"* (1) to *"Definitely intend"* (7).
[d] Number days participated recorded steps data on UWALK website during the 12 weeks following first day registered in UWALK.

The larger UWALK program's quantitative findings (Jennings et al., 2017), previous local research in this area (e.g., Clark et al., 2010; Montemurro et al., 2011), previous reviews of qualitative evidence on built environment and physical activity (McCormack et al., 2010; Salvo et al., 2018) and the socio-ecological model of physical activity (McLeroy et al., 1988; Stokols, 1992) informed the semi-structured interview guides. For instance, participants were asked to describe their neighborhood and personal characteristics that facilitated or impeded their attempts to participate in UWALK. They were also asked how they overcame neighborhood and personal constraints when attempting physical activity, their views about the type of environment that would create an "ideal" physical activity supportive neighborhood, and their experiences with the UWALK web platform. The interview guide was adjusted slightly based on the participant's engagement with UWALK. For individuals who did not record any steps (n = 1), questions emphasized potential barriers and observations about their neighborhood while for others questions focused on their specific experiences of personal and neighborhood barriers and facilitators of engaging in UWALK.

Following procedures for qualitative descriptive inquiry, the interviewer who was experienced in conducting qualitative interviews via telephone, remained reflexive and interactive throughout the interview, often including probing questions in an effort to garner a deeper, more detailed description of participant's experiences (Sandelowski, 2000). The interviewer has been involved in the collection and analysis of qualitative data in other research exploring motivation and exercise adherence (Larson et al., 2018). The interview had no prior contact with participants nor was she involved in the coordination of the UWALK intervention. Audio recordings of interviews were transcribed verbatim and all identifying information (e.g. participant name) were removed from completed transcripts. To ensure anonymity throughout the analysis and reporting phases, all participants were assigned a pseudonym by the research team.

2.5. Data analysis

Qualitative description involves little inference (Sandelowski, 2000), therefore, interpretation of data was based on direct extractions from participants' quotes. To accommodate the necessity for an iterative approach when reviewing the data, the authors used an inductive content analysis method. Content analysis is an optimal approach for qualitative description studies (Sandelowski, 2000). Elo and Kyngäs (2008) describe a three-step process for content analysis: preparation, organizing, and reporting. The initial *preparation* phase of analysis involved the primary coder reading and rereading all anonymized transcripts to become familiar with the data. For the *organizing* phase, the primary coder engaged in "open coding" whereby notes or headings were recorded in the transcript margins in an effort to describe all aspects of the content (Elo and Kyngäs (2008)). The headings were then used to create categories (e.g., "coping with barriers", "being accountable") that were then collapsed into higher-order themes (e.g., "commitment to physical activity"). The primary coder then created a table of categories, themes, and illustrative quotes. A second coder then reviewed the transcripts, verified the content of the results table, and made recommendations regarding consolidation of certain categories. A third coder was then included to take a broader overview of the data presented by both coders and provide feedback on the coherence of themes and quotes. The final *reporting* phase involved consolidating the categories and themes in order to construct the results section, which includes direct quotations from participants.

Consistent with ontological relativism, a relativist approach to rigor was used within this research. Specifically, given that standards used to evaluate qualitative research are dependent on the study's purpose and context, the criteria for evaluation were selected while engaging with the research (Smith & McGannon, 2018). Consistent with the considerations outlined by Smith and McGannon (2018), this research was guided by be a *worthy topic,* as there are a lack of studies that have explored how characteristics of the environment impacts physical activity interventions, and such understanding is necessary to improve intervention delivery and effectiveness. As well, this research demonstrated *coherence* in that the qualitative description approach informed the participant sampling, as well as the data generation and analysis. The purposeful selection of participants from a large sample of inactive adults who had self-selected to participate in UWALK, contributes to the *utility* of this research to deepen understandings of this worthy topic. Finally, conversations among *critical friends* (i.e., co-authors) facilitated the interpretation of findings within the broader physical activity intervention literature.

3. Results

The experiences shared by participants are represented by four themes: (a) creating (in)activity awareness, (b) commitment to physical activity, (c) incorporating activity for transportation, and (d) importance of nature and changing scenery. Consistent with the socio-ecological model (Spence & Lee, 2003), these four themes reflect the multiple interactions and pathways by which individual and environment barriers and facilitators can affect the experiences of UWALK intervention and, in turn, physical activity. We present examples of participant quotes that best represent and support each identified theme.

3.1. Creating (in)activity awareness

Participants commented about how helpful UWALK was in increasing their awareness of how active or inactive they were. Wearing the pedometer and having to record their daily step count made them more mindful of time spent being inactive. As Steve explained:

> *I just became more aware that if I just sit at the computer all day and do my work, then I'm not going to reach my steps, but on those days when I would, you know, walk or do something different, that I would definitely reach my steps, so I did become more mindful about doing that.*

Nancy commented about how useful a tool the pedometer is for increasing awareness. She highly recommended more people start tracking their steps as it can be a good learning experience for those who might overestimate their activity levels:

> *I guess what I found the most helpful is wearing that counter and you don't realize how little you're doing until you actually see it and I think it was great because it really gave me an eye opener […] I think it's excellent in showing people, giving people a reality check of how much they're not doing.*

She elaborated on this point by telling a story involving her sister's assumptions about how many steps she takes in a day:

> *Well my sister said, "I walk 10,000 steps a day," so I lent [my pedometer] to her one weekend when I was out there. Yeah, she walked it was a little over 4,000. I looked at her and I said, "yeah, you're doing 10,000 a day huh?" So, it's good learning and I'd like people to see that.*

Participants also mentioned how participating in UWALK helped them develop their own goal setting and how it was a useful motivational tool to become more active. As Frank pointed out, keeping track of your progress helps you do a little extra to meet your step goal:

> *You know you set the goal of 10,000 a day and when you're not doing that, you go take the dog for an extra walk or something so it does, yeah, it gives you a benchmark and you know you do get motivated.*

Hannah also reinforced the idea that checking your steps throughout the day can prompt you to do more:

> *This just gave me the incentive 'cause I looked at it, saw 'oh my God I only did 5,000 steps before, get moving!' Right? So, it would give you*

that extra push.

Overall, participants from all groups found UWALK helpful in improving their awareness of how much time they spend not being active each day. In particular, they found the pedometer a useful tool in both informing them of their inactivity and motivating them to move more.

3.2. Commitment to physical activity

Participants demonstrated a commitment to physical activity in discussing methods they used to increase their steps, cope with barriers they experienced throughout the UWALK program, and being accountable to the research study, themselves, and others. In order to honour their commitment to UWALK several participants developed strategies to ensure they met their step count goals. As Madeline explained:

I've found just getting out there and doing the walk first thing in the day was the best thing for me because then I knew I'd met my obligation and then I didn't have to think about how, you know, when I was going to fit it in.

Pamela described another strategy she used to create more opportunity for walking, which she found necessary since she did not live in area that was amenable for walking to stores:

What I did start to do is actually purposely park further from the store, like I found it was like, oh well I don't need to park like right outside the door. I can park you know halfway through the parking lot, I can walk further so I started to make that change.

Several participants discussed barriers to walking including inclement weather and unfavorable outdoor conditions. However, those who adhered to UWALK were more likely to mention developing strategies to cope with those situations. Julie explained:

It was a pretty rainy season, so I did miss some opportunities because of the weather, but I eventually sucked that up and was like, 'okay I'm going to bring an umbrella or like, you know, a waterproof jacket and even though it's cold and damp I'm still going to get my steps in.'

Participants also alluded to having a higher sense of purpose or being accountable to others as a reason for developing strategies to facilitate their success. Madeline mentioned altruism as she explains what drove her to adhere to the study protocol and successfully complete the walking program:

Being accountable to somebody else that maybe it has to be some kind of authority or altruistic thing, somebody who's trying to make life better or whatever, that made me feel very good about contributing to some information that might make a difference in how our neighborhoods are planned or that would be helpful to people to be active.

She further discussed how her participation and walking behavior inspired others, which then made her feel accountable to them as a model of healthy behavior:

Three or four of my friends said "oh Madeline, you've inspired me, you know I'm trying to get more walking in or doing my cycling", so that was motivating for me too.

Other participants discussed needing a sense of purpose for their walking as opposed to just going for a leisure walk. For them, walking was a means to an end rather than an end in itself. As Victoria described:

I don't walk for the sake of walking. I'm not very good at that. I'll walk to get things done and then most of the days where I did really well, it was activities that I'm already involved in like soccer or just walking around but not for fun, shopping or something like that.

Caroline further added to the point of functional or purposeful walking by stating that she is more likely to walk if there is someone else who needs or wants her to do so:

If I had a dog or if I'm going with a friend and we're yapping the whole time, there's much more incentive […] I'll walk over to see my daughter and grandson, walk to school to pick up my, my grandson, things like that, functional, purposeful walking.

Participants worked hard to develop their own tactics for including steps, particularly when walking proved to be a challenge. Little rules or strategies they created for themselves made it easier to meet their goals. Participants who adhered to UWALK described a strong sense of accountability to the research team or to inspiring others, while those who did not progress far in the study were more likely to discuss not having, and therefore needing, a purpose for their walks.

3.3. Incorporating activity for transportation

Participants' frequently discussed active transportation as an effective way of increasing their daily steps. As Madeline explained, UWALK helped change the way she thinks about getting from A to B:

I noticed that [walking] popped into my head, you know, which hadn't happened before. I'd just think, 'oh, I want to get this done, I'm going to jump in my car and do this.'

Hannah also made a conscious effort to walk instead of drive:

Sometimes I'd make a point of going you know I just needed milk so I would go walk to the grocery store versus driving my car.

Family members who encouraged non-vehicular means of getting around town sometimes reinforced active transportation. Victoria explained how her husband often encouraged walking for any errands that were not too far from home:

Well my husband always wants to walk if we're going somewhere closeish like there's a lot of things we can walk to within a kilometer and that's kind of the rule, we walk if it's less than a kilometer, so that made it easier.

Other participants discussed how distance was a deterrent and how they would like to have stores within walking distance so they could do more on foot. Rachel mentioned the length of time it takes her to get to and from the store:

We don't have any stores really close to us like it's a good, well it's basically 50 minutes, it's either 50 minutes round trip or 60 minutes round trip.

Participants across all groups mentioned living close to stores, particularly those that hold necessities such as food, clothes, or household goods, as a strong facilitator for walking. Participants discussed how much easier it was to incorporate walking when it could be a part of their daily errands. Those who lived far from stores complained about it being a barrier and suggested city planner's factor in quick and easy access to stores on foot in all neighborhoods.

3.4. Importance of nature and changing scenery

When discussing facilitators and barriers, all the participants talked about access (or lack thereof) to nature or beautiful scenery. Depending on where they were residing within the city, this could mean views of mountains, access to rivers or human-made ponds, or even just interesting gardens or decorations in front of houses. As Frank explained:

The neighbors all, you know, take pride in their properties and things like that so they're all you know some spectacular gardens. They all get into major Christmas decorating and, and Halloween decorations and everything so it's, it's always interesting. Some of the neighbors are a little bit more, we'll call it more artistic and do some strange things, but it's always interesting to walk by and see what's new.

Madeline discussed how access to the natural scenery in her neighborhood was motivating to get her out for walks:

I live a block and a half from the Bow River and there are trails all along the river. I could so it was extremely easy for me to be within you know five minutes in a beautiful natural setting so I could walk along the Bow River through Bowness Park and cross the river and come back staying low level or I could go up to Silver Springs and get a view through to the mountains and walk and look down on the valley so being close to such a beautiful natural area right out my back door made it very pleasurable and I really enjoyed that.

Olivia mentioned how having designated walking and cycling paths at a park near her house makes walking more appealing for her:

There's a really nice park, like, it has a well-defined bike path and, like, a walking pedestrian thing, so that's quite helpful. There's lots of greenery and, like, footpaths so I enjoy that.

Some participants discussed how they didn't have access to green spaces and that ended up being a barrier to making daily walks desirable. Abigail discussed her neighborhood being visually under-stimulating and, even, unwelcoming to those traveling on foot:

It's not that stimulating. It's just houses and shops and yeah it's not very stimulating and also there is a green space, but again, it's just people sleep there overnight because they're homeless and also there's lots of garbage and people have their dogs off leash.

Karen had some suggestions of how to improve her neighborhood to make it more appealing to walkers:

Beautifying it a little bit … like a couple little trees, big flower planters and things like that or like a, like a little water fountain … it would be more inviting to go.

Some participants had their own strategies for dealing with the monotony of walking the same routes repeatedly. Pamela discussed how she and her husband took trips to other communities in the city to do their walking:

In the summer we, we did actually start to say let's jump in the car and let's go and explore some new communities that are, that are starting to pop up around and we were like pleasantly surprised how much nicer and how much more walkable those communities were.

Elizabeth came up with her own unique way of keeping things interesting, seeing new sights, and distracting herself from the chore of walking:

I like the shopping part, like the window shopping part right so that's why sometimes I'll take a walk, the days that I have a higher count is the days I probably go to the mall […] it distracts me from the fact that I'm actually doing an exercise by walking right around and looking.

All participants discussed either the presence or absence of nature and/or changing scenery within their neighborhoods. Having beautiful and interesting scenery with designated walking paths was a facilitator for some, while having to look at the same thing repeatedly or being in a less attractive neighborhood was a barrier for others. Everyone mentioned to some degree that additional green space and variety of scenery (e.g. changing gardens, rotating artwork installations, different decorations for each season) in their neighborhoods to could make walks more appealing.

4. Discussion

Our study explored factors that hinder or facilitate physical activity among previously "inactive" adults during the UWALK 12-week community-based internet-facilitated pedometer intervention. Four themes representing participants' experiences of UWALK reflect individual, social and physical environment barriers and facilitators of physical activity. Our findings, which are grounded in the experiences of participants, highlight important considerations for improving the delivery and effectiveness of pedometer interventions.

Tracking pedometer steps motivated our participants to be physically active. Similar to findings elsewhere (Gardner & Campagna, 2011; Heesch et al., 2005; Jones et al., 2009; Shaw et al., 2011; Thorup et al., 2016), we found that this motivation was often driven by the participant's increased awareness of their current physical activity levels as a result of checking the pedometer's step count display. It is well known that adults inaccurately self-report their physical activity levels (Prince et al., 2008) – evidence which is supported by our qualitative findings whereby some participants perceived their physical activity levels to be much higher than was really the case, and where this misperception became apparent through wearing the pedometer. An advantage of wearing pedometers during interventions and non-interventions is that the participant can modify their own behavior to achieve step count goals, as a result of receiving a real-time, objective, indicator of their physical activity (via step counts). However, it may not be sufficient for participants to check only their step counts in order to improve their physical activity. Pedometer interventions might be more likely to improve physical activity levels when participants are required to regularly record their steps (Bravata et al., 2007). The accountability required during pedometer interventions, as a result of recording and sharing of steps with important others (friends, family, and study co-ordinators), can encourage participants to further increase their steps (Gardner & Campagna, 2011; Heesch et al., 2005; Jones et al., 2009; Shaw et al., 2011; Thorup et al., 2016). Despite increased awareness of one's physical activity levels while wearing the pedometer, and evidence showing increases in physical activity during pedometer interventions, the extent to which gains in physical activity remain post-intervention is unknown (Bravata et al., 2007; Mansi et al., 2014). Our qualitative study did not investigate factors associated with UWALK after the 12-week formal study period. There is a need for more studies that investigate the contribution of socio-ecological factors on physical activity maintenance following participation in internet-facilitated pedometer interventions.

Pedometer interventions that recommend participants achieve steps goals are generally more effective for increasing physical activity levels than those interventions without step goal recommendations (Bravata et al., 2007; Kang et al., 2009). Notably, many participants in our study reported being committed to UWALK and developed strategies for ensuring they reached their step goals. Some strategies included walking with the dog or with family or friends, prioritizing physical activity by undertaking walks at the beginning of day, purposely parking their vehicle further from destinations to accumulate more walking, and walking instead of driving from home to visit local stores. Some of these strategies, such as walking the dog or walking with friends, and parking the car further from destinations, have been communicated in national physical activity promotion materials to encourage recommended levels of physical activity (Commonweath of Australia, 2014; Government of Canada, 2011). Qualitative evidence elsewhere has identified similar strategies used by participants to meet step goals during pedometer interventions (Gardner & Campagna, 2011; Heesch et al., 2005). For example, among women who were not currently achieving recommended physical activity levels, participants reported wanting more advice during their pedometer intervention regarding strategies to overcome poor weather and more information regarding places in their community to walk (Heesch et al., 2005). Sharing an inventory of effective strategies used by others for accumulating physical activity while involved in internet-facilitated pedometer interventions (or any other physical activity intervention) could be useful for assisting participants in overcoming barriers and increasing physical activity. Speculatively, such strategies may eventually become habit, which could contribute to physical activity maintenance after the individual discontinues wearing the pedometer (Gardner, 2015; Kaushal, Rhodes, Spence, & Meldrum, 2017).

Our findings support other qualitative evidence suggesting functional, destination, safety, and aesthetics features in the local built environment to be important barriers or facilitators of physical activity (McCormack et al., 2010; Salvo et al., 2018). Our participants mentioned or alluded to the proximity of destinations (e.g., stores) and recreation facilities (e.g., parks and rivers), availability of attractive or interesting sites (e.g., private gardens), natural scenery, and cycling and walking paths as enablers of physical activity during UWALK. Having places to walk such a malls and local supermarkets, and access to nature are facilitators of physical activity reported previously by pedometer intervention participants (Jones et al., 2009). Our participants also reported under-stimulating or uninteresting neighborhoods, the presence of garbage, homeless people, and off-leash dogs, the lack of destinations within walking distance, and the lack of green space as barriers to physical activity while participating in UWALK. Jones et al. (2009) also found dogs to be a perceived barrier to physical activity among some participants in their pedometer intervention. Unlike previous studies however (Jones et al., 2009; Salvo et al., 2018), we did not find traffic safety concerns to be a barrier to physical activity among our participants.

As expected, given previous evidence (Clemes et al., 2011; Hamilton et al., 2008; Heesch et al., 2005; Jones et al., 2009; Shaw et al., 2011; Tudor-Locke et al., 2004), weather was also a barrier to physical activity among some UWALK participants. Notably, despite our study being undertaken in a Canadian city that experiences sub-zero temperatures and snow and ice during winter, rain was the only weather condition that negatively impacted physical activity during UWALK. Despite our year-long recruitment of participants, it is possible that our qualitative sample did not include individuals who participated in UWALK during winter months or that winter conditions are less likely to be a barrier to physical activity among those who are motivated to participate in UWALK. Therefore, providing participants with strategies for overcoming built environment and weather barriers to physical activity could assist them in achieving step goals and increasing their physical activity (Heesch et al., 2005; Jones et al., 2009; Shaw et al., 2011). The strategies might include providing participants with maps that highlight walkable routes and or show interesting landmarks within or close home and showing alternative locations where physical activity can be undertaken during inclement weather.

Our findings are consistent with quantitative evidence that perceptions of the built environment's supportiveness for physical activity can modify the effects of health promotion interventions (Gebel et al., 2011; Kerr et al., 2010; King et al., 2006). However, a novel contribution of this study was the observation that different levels of determinants as posited by the socioecological model (e.g., personal, social environment, and physical environment) can affect participation in health promotion interventions, and in particular, in internet-facilitated pedometer interventions. Though building supportive neighborhood environments will improve the likelihood of success of physical activity campaigns and programs, more research is needed to better understand which and how built environment features facilitate or hinder the effectiveness of such interventions.

Our study has several limitations. First, it is possible that the opinions expressed by our sample regarding barriers to physical activity differ to those who chose not to enrol in UWALK. Second, telephone interviews may have affected the representativeness of the sample, and therefore responses to questions. But, we undertook semi-structured interviews via telephone because of the convenience in terms of scheduling around participant schedules, the reduced cost and less time needed relative to face-to-face interviews, because it allowed participants to maintain some level of anonymity, and the nature of the questions (e.g., non-sensitive) was unlikely to be affected by the interview mode. It is possible that using telephone interviews, relative to face-to-face interviews, resulted in shorter interviews, fewer questions asked, responses with less detail and or elaboration (potentially reducing the coverage of themes), missed opportunity to interpret body language and other visual cues (potentially omitting important contextual information accompanying responses), and less opportunity to build rapport with the participant (Irvine, Drew, & Sainsbury, 2013).

Finally, the structure and format of the UWALK intervention likely affected participant's responses, which means our findings may only be transferable to other pedometer interventions that share similar features with UWALK. However, in non-intervention studies, adults have perceived the built environment to be a barrier to unstructured physical activity (McCormack et al., 2010; Salvo et al., 2018) suggesting our findings are congruent with prior knowledge.

Despite these limitations, the recruitment of "inactive" adults for the initial study and subsequently used in this rigorous qualitative study, the capturing of perspectives from participants with different levels of UWALK adherence and participation, the representation of adults from different sociodemographic backgrounds and from neighborhoods of varied walkability, and capturing of qualitative data in relation to a province-wide, theory-informed, internet-facilitated pedometer intervention are considered strengths of this study.

In summary, the neighborhood built environment contributes to the effectiveness of internet-facilitated pedometer interventions. More generally, this study contributes to previous evidence suggesting the neighborhood built environment is important for physical activity and importantly that it has the potential to impact health promotion interventions designed to increase physical activity. Thus, researchers and practitioners should take into consideration contextual factors when developing, adapting, and implementing individual-targeted physical activity interventions, including internet-facilitated pedometer interventions. Moreover, our study findings suggest urban and transportation planners play an important role in ensuring neighborhoods incorporate features that support physical activity. In addition to providing pedometers, developers of these interventions should provide participants with guidance for overcoming potential barriers and provide evidence-informed strategies that participants can use to accumulate their daily steps.

Declaration of interest

None.

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