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Seasonal differences in mobility and activity space in later life: a case study of older adults in the Northern Netherlands

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ABSTRACT

Mobility is crucial for maintaining well-being in later life. Previous research has shown that older adults’ mobility fluctuates throughout the day, with a particular focus on afternoon outdoor movement. This paper takes a broader approach and explores the seasonal differences and similarities in mobility and activity space in later life, using older adults in the Northern Netherlands as a case study. Seventeen older adults participated in the study, for which we used a mixed-methods approach combining GPS-, activity diaries, and in-depth interview data analysed through grounded visualisation. We have collected data from each participant for a week, once during fall/winter and once during summer. The findings of this paper defy common expectations around older adult mobility; for instance, the participants walked less in summer and had a larger activity space in winter. Equally, we demonstrate that it is crucial to distinguish between daily and incidental activity spaces, particularly when factoring in seasonal variations. Yet our mixed-methods approach revealed discrepancies between perceived and measured mobility and activity space. We argue that the intricate interplay of seasonal influences, weather conditions, and personal factors significantly shapes mobility practices in later life, underscoring the need for holistic planning of age-inclusive environments.

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KEYWORDS

Mobility; older adults; mixed-methods research; grounded visualization; the Netherlands; activity space

1. Introduction

Mr. Koster is in his early sixties and lives with his wife in a suburban neighbourhood. During winter, he heavily relies on his car to engage in almost all everyday activities. When he has time, he walks to the supermarket close to his house for some groceries and to get some exercise. In summer, he does use his car too, but to a smaller extent. Rather, he goes out to engage in recreational walks and bicycling tours. He both enjoys being mobile in itself, and as a means to engage in everyday activities that he enjoys.

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Mobility is vital for well-being in later life (Nordbakke and Schwanen 2014). Not only can being mobile be an aim in itself but it can enable older adults to engage in meaningful activities (Meijering 2021). Older adults often have fewer fixed-time commitments, such as employment, so they are likely to experience relative freedom in their everyday movement. At the same time, physical and cognitive impairments, such as arthritis and forgetfulness, are likely to occur (Clouston et al. 2013). These may result in limitations in mobility, such as difficulties walking or driving cessation (Hansen et al. 2020; Rantanen 2013). Overall, with a likely increase in mobility limitations, older adults travel shorter distances and their activity space is smaller compared to their younger counterparts. Consequentially, older adults may experience reduced independence and control in light of constraints on their everyday mobility (Stjernborg, Wretstrand, and Tesfahuney 2015). At the same time, older adults are creative in adapting their routines to maintain satisfactory levels of mobility, enabling them to engage in meaningful activities in and with familiar places and people (Franke et al. 2017). This emphasis on familiarity ties in with more general evidence that mobility is largely habitual (Olsen et al. 2022).

However, there is some evidence that outdoor mobility in later life varies over time in the sense that older adults tend to avoid going out at night and engage less in outdoor mobility in adverse weather circumstances (Meijering and Weitkamp 2016; Böcker, van Amen, and Helbich 2017; Lager, Van Hoven, and Huigen 2015; Portegijs et al. 2014). Although the concept of mobility is well-suited to study the temporality of movement, the evidence base is limited (Adey et al. 2014; Coletta, Röhl, and Wagenknecht 2020). It is important to address this gap since everyday movement and activity spaces are likely to change with seasonal variations in daylight hours, temperature, and weather circumstances. Therefore, this article explores the seasonal differences and similarities in mobility practices and activity space in later life in the Northern Netherlands. To achieve this, we integrate and compare the everyday movement of a sample of 17 older adults collected in both autumn/winter and summer. For our case study, we use a mixed-methods approach that combines insights into objectively measured and subjectively experienced mobility (Meijering and Weitkamp 2016).

2. Theoretical framework
2.1. Mobilities and time geographies

By exploring the activity spaces and mobility practices in later life over the year, this paper builds upon mobilities and time geographies as a foundation. Mobility, in the simplest sense, is the actual movement or capacity to move through physical space. Yet, since the mobilities turn at the turn of the century (Sheller and Urry 2006) there has been a move away from mobility functionalism – the idea that mobility is little more than getting from A-to-B – and stressing ‘the importance of the systematic movements of people for work and family life, for leisure and pleasure, and for politics and protest’ (Sheller and Urry 2006, 208). This has paved a whole new agenda in the social sciences, and seen across this journal, theorising and empirically examining the mobilities and immobilities, of people, materialities, ideas and information (Ziegler and Schwanen 2011).

In recent years, there has been an increasing body of trans-disciplinary work looking at mobility practices, patterns, experiences, and capabilities in later life. Indeed, Nordbakke and Schwanen (2014) argue that the majority of research on potential and actual movement affects well-being has centred on older adults. This work has included discussions around public transportation (Ravensbergen et al. 2021), mobility habits (Hirsch et al. 2014), indoor mobility (Sattari, Weitkamp, and Meijering 2023), everyday mobility (Ziegler and Schwanen 2011) as well as loss of mobility (Curl et al. 2014) and stillness (Osborne and Meijering 2023). As such, this work has incorporated quantitative and qualitative approaches and considers mobilities at various scales and temporalities.
While the existing literature has substantially broadened our understanding of mobility from a trans-disciplinary perspective, time geography offers a unique lens through which to explore the complexity of mobility practices in later life. Time geography is a powerful framework for understanding constraints on older adults’ individual participation in everyday activities in space and time. The framework provides a concrete representation of individual activities in space in relation to time at various temporal scales of observation (Hägerstrand 1970; Ellegård and Svedin 2012). This gives insight into the role of these basic but crucial conditions for movement behavior and mobility of older adults. In recent years, the advancements in location-aware technologies such as GPS, and new scientific and policy concerns that focus on individuals with a variety of characteristics, barriers and needs, emphasizes the relevance of the framework of time geography for analyzing human spatial behavior (Montello 2018). The concept of activity space has been an effective derivative concept to analyse and visualise space-time relationships in the context of mobility of older adults.

2.2. Mobility and activity space in later life

In recent years, the concept of activity space, as ‘the subset of all locations within which an individual has direct contact as a result of his or her day-to-day activities’ (Golledge and Stimson 1997, 279), has been used to explore various mobility patterns across space (Hasanzadeh et al. 2021; Hirsch et al. 2016; Kim and Ulfarsson 2015; Smith, Foley, and Panter 2019). The holistic nature of activity space allows researchers to consider the size of activity space, the various activity types, modes of transport, and time spent at different places in their studies on mobility. Within an activity space, sub-activity spaces can be distinguished based on different nodes, such as the home and work location. Typically, the home is the most important node, as Li and Tong (2016) have shown for a large sample of respondents in Arizona. This has been supported by Hasanzadeh et al. (2021), who compared the centricity of activity spaces of older and younger adults in Helsinki, Finland. They found that older adults most often have a monocentric activity space, consisting of the home as the one significant cluster, while younger adults most often have a bicentric or polycentric activity space, consisting of two or more significant clusters. The prevalence of monocentric activity spaces in later life can partly be explained by living in a dense neighbourhood with high access to services (Kim and Ulfarsson 2015). Such a monocentric activity space may have additional health benefits because it facilitates active transportation. However, more negative explanations for such monocentric activity spaces in later life can lie in experienced mobility restrictions and social exclusion (Hasanzadeh 2019; Hasanzadeh et al. 2021).

Recent research has argued that activity space and mobility in later life are characterised by destinations both within and outside their immediate neighbourhoods (Franke et al. 2017; Hasanzadeh et al. 2019; Hirsch et al. 2016). This includes travel to amenities such as stores, libraries, theatres and parks. In a study that focused on older adults with memory problems, Sturge et al. (2021) contrasted routine activity spaces within a buffer of around 7.5 km from their homes, with occasional activity spaces located further away. They found that older adults experiencing memory problems can typically engage independently in activities within their familiar routine activity spaces. Sturge et al. (2021) work aligns with other research that has emphasised the importance of familiarity with environments in later life (Franke et al. 2017; Lager, Van Hoven, and Huigen 2015). They found evidence of older adults frequenting familiar services such as shops farther away from their homes and not moving around much in their immediate neighbourhoods. In short, although activity space in later life is often monocentric, it is too simplistic to assume a buffer area around the home is a realistic representation (Hasanzadeh et al. 2019; Hirsch et al. 2016). Therefore, it is important to move beyond ‘simple’ geographical boundaries that apply to all.
2.3. Seasonality and mobility in later life

Despite the vast body of work critically applying activity space in mobility studies, the impact of seasonality (including variations in daylight, temperature and precipitation) is often overlooked even though it has been shown to have an impact on mobility and activity space – especially in later life. For example, Portegijs et al. (2014) explored mobility in later life in spring and winter in Finland, studying the distance, frequency and level of independence as part of life space mobility. A key finding from their work highlighted that older adults’ life space appeared smaller in winter compared to summer. This seasonal decline in mobility in the winter months has been echoed by other studies across the global north (Amagasa et al. 2020). These findings resonate with work on ‘whitespace’ in health geography, which foregrounds the diverging impact of snow and ice on mobility and well-being in later life (Finlay 2018). Finlay found that ‘whitespace’ has a divergent and contextualised impact on older adults’ mobility and well-being. Some older adults are afraid to go out in snowy and icy conditions, which may result in negative effects such as fear of falling, decreased physical activity, social isolation, and boredom. Others, however, enjoyed the cold and would take the opportunity to go out and be active as much as possible. An important result was also that the harsh winter conditions served to enhance the social connectedness between older adults living in the same neighbourhoods.

Beyond snowfall and extreme winter conditions, it is important to reflect on the seasonal differences in temperature especially since the older population is at greater risk from increased heat. Indeed, it has been shown that older adults are more likely to change their daily mobility due to heat compared to their younger counterparts (Clarke et al. 2015). This is echoed by a study in the Netherlands that demonstrated how older adults’ sensitivity to heat with fewer out-of-the-home trips made than during periods of cooler temperatures (Böcker, van Amen, and Helbich 2017). It is well recognised that the global increase in temperature will have a detrimental effect to the health of older adults (Meade et al. 2020), but further consideration on the impact of heat on mobility practices (and consequential well-being) needs to be explored further.

Another crucial difference between the seasons is that of daylight hours. Aside from in the equatorial areas of the earth, the daytime length varies depending on the season. In the winter (starting in December in the northern hemisphere (NH), and June in the southern hemisphere (SH)), there are shorter periods of daylight hours compared to the summer months (June in NH, December in SH). Due to issues related to perceived safety and difficulties seeing, especially when linked to depth perception, it has been argued in (qualitative) research that older adults prefer not to go outside after dark, but instead choose to undertake their outdoor activities in the afternoon (Meijering and Weitkamp 2016; Lager, Van Hoven, and Huigen 2015; Rosenberg et al. 2013). Quantitative studies, however, have only found slight associations between activities and daylight in later life (Klenk et al. 2012; Prins and van Lenthe 2015).

Seasonality clearly influences mobility in later life, but to our knowledge, no studies combine activity space with the effect of the seasons. In doing so, our paper will unpack the various elements of seasonality (namely, temperature, daylight, and precipitation) to further the emerging literature on the seasonal aspects of mobility in later life, and provide insight into the impact of season-specific opportunities and barriers using the case study of older adults in the Northern Netherlands as an example.

3. Methodology

3.1. Study context and approach

This study was carried out in the Northern Netherlands, which includes the provinces of Groningen, Friesland and Drenthe, with a total population of around 1.6 million inhabitants on a
surface of around 11,500 km². The largest urban centres are Groningen (~238,000 inhabitants), Emmen (~107,000 inhabitants), Leeuwarden (~94,000 inhabitants), and Assen (~64,000 inhabitants) (CBS 2022). The average population density is 212 persons per square kilometre, which is well below the average for the Netherlands as a whole (529). The region is largely flat and well suited to cycling. The Northern Netherlands is further unlocked by highways, provincial roads and railroad tracks. There are train stations in the major towns, as well as in some relatively small villages in the provinces of Groningen and Friesland.

For this study, we used a converging mixed-methods approach including GPS tracking, activity diaries, and in-depth interviews, to ‘follow’ our participants and get insight into their mobilities and activity spaces (see Breines, Menet, and Schapendonk 2021). The mixed-method approach offers a range of advantages for studying mobility. It allows the integration of the quantitative GPS-based analytic approaches with the qualitative methods of in-depth interviews and diaries. This combination provides a multi-layered understanding of mobility by validating and enriching GPS data with personal insights from participants. Quantitative spatial data can highlight patterns in physical activity and the use of space, while qualitative data offer context and meaning, explaining the reasons behind these patterns. Moreover, the value of GPS data is particularly relevant to micro-level movement behaviour, as it helps identify nuanced details in mobility patterns that might otherwise go unnoticed or ‘seen’ with research subjects (Fincham, McGuinness, and Murray 2010; Meijering and Weitkamp 2016). This approach can reveal the complexities of mobility that single-method studies might miss; complementary and contrasting results from the different methods can be used to generate new insights.

Indeed, this approach enabled us to get insight into both broad patterns and individual stories, which we balance and bring together throughout the article. All data have been collected from the same sample of participants during both the fall/winter of 2019/20 (November–March) and during the summer of 2020 (July–September). We did collect data throughout this time period, which means that there is some variation in the weather circumstances between participants. Still, in light of the general weather and seasonal differences in terms of temperature, rain and daylight, our approach enabled us to study the effect of seasonal weather variations on mobility practices and activity space. Participants lived in different places in the Northern Netherlands, both urban and rural. This is likely to impact their mobility and activity space, which we discuss more elaborately in another article (Meijering and Weitkamp 2023).

### 3.2. Participant recruitment

Participants were recruited through events held in the Northern Netherlands targeted at older adults, where the research team held pitches and handed out flyers. In addition, participants were recruited via interest groups, our lay advisory group and snowballing techniques. Inclusion criteria were: being aged over 55 and living at home independently – alone or with someone else- in the Northern Netherlands. We used the age of 55 as a cut-off point because of the onset of age-related impairments around that age. In light of this age-range, three of our participants were engaged in paid work, which impacted their mobility and activity space. We included participants who self-reported common physical and/or cognitive impairments that come with age. As a result, our participant sample is a diverse group of older adults.

### 3.3. Methods of data collection

Participants were asked to record an activity diary and carry a GPS tracker for a week. This time-frame is common with these methods, since it provides insight into a week as a recurring entity of time (Kerr et al. 2011). For GPS-tracking, we used a QStarz BT-Q1000XT. The GPS-data were overall of good quality, but there were some inaccurate location points. Note that for Participant
GPS data was collected for only two days during the seven-day winter data collection period, which was used to calculate their activity space. According to the activity diary, the true dimensions of their activity space are likely to be larger than what the limited GPS data suggests. The participants all kept their activity diaries, and wrote in their activities and recorded activities, destinations, companions, modes of transport used as well as brief reflections on their experiences. However, the level of detail provided varied enormously, with some participants only writing down the nature of their activities during each morning, afternoon and evening, and others providing accounts of their activities, almost from minute to minute and including, for instance, detailed information on routes taken as well as reflections on social interactions and experienced emotions.

The collected data were then used as input for discussion in the in-depth interviews, such as motivation for taking specific routes and for stopping at different points. Also, feelings around activities and places were discussed. The in-depth interviews were audio recorded and lasted for about one hour. The summer period of data-collection took place between July and September 2020 which was during the COVID-19 pandemic. In June, services such as schools and public transport were opened again, as were restaurants and cafes and restrictions on socializing were abandoned. COVID-19 tests became available for everyone. The summer was characterised as a ‘one-and-a-half meter summer’ during which society ‘was done with the virus’ (Rijksoverheid 2023). As cases were rising from August onwards, new measures were announced in September – which was after the period of data collection. Although there were little formal restrictions, everyday life was characterised by socialising outdoors and meeting in relatively small groups. In light of the pandemic, some of the in-depth interviews were carried out by telephone.

### 3.4. Data management and analysis

The GPS data was converted into point data and processed in ArcGIS Pro to define places and trajectories. Activities were identified by movement within a bounding box with a diameter of 80 metres for at least 5 minutes and then spatially clustered to define places. The remaining points were converted into lines, representing trips or trajectories between places. This resulted in 493 trajectories during summer and 453 trajectories during fall/winter. Attributes of start time, end time, duration, speed, activity and place type at the origin and destination, mode of transportation, weather and daylight data, were added to the trajectories. Activity spaces were computed by creating convex hulls around trajectory lines for each participant for comparing between summer and fall/winter, and for comparing activity spaces during good or bad weather conditions, and using active or motorised modes of transportation. Inferential statistics were used in SPSS to compare the sizes of activity spaces and distances travelled between summer and fall/winter.

The activity diaries were typed down and anonymised after being collected from the participants. The in-depth interviews were transcribed verbatim and anonymised. The qualitative data on mobility experiences collected in in-depth interviews and activity diaries was analysed according to the principles of thematic analysis (Braun et al. 2019). The data were coded around the seasons and weather circumstances, participants’ reflections and emotions around these, as well as the activities that they undertook and transport modes they used. Themes that emerged reflected the role of seasons and weather with regard to mode of transportation and the motivation to undertake different activities.

We adopted a grounded visualisation approach to data-analysis (Knigge and Cope, 2006). This approach combines grounded theory and visualisation to construct an integrated analysis strategy that is both iterative and reflexive, both contextual and conceptual” (Knigge and Cope 2006, 2021). Grounded visualisation is a rigorous approach well-suited to uncover the multiple meanings associated with a topic (Franke et al. 2017). In the iterative grounded visualisation process,
the spatial data on mobility patterns and the qualitative data on mobility experiences was compared and integrated to identify similarities and differences in terms of places frequented, modes of transport taken, and activities undertaken, in different seasons and weather circumstances.

3.5. Research ethics

As is common when working with older adults, especially experiencing cognitive impairments, we applied rolling informed consent throughout the research process (Groen-van de Ven et al. 2017; Novitzky et al. 2015; Prusaczyk et al. 2017). Rolling consent means that we saw the participants’ informed consent as a process. Informed consent was sought before the start of the data collection, and re-addressed during the research process. Concretely, this means that (1) information is provided repeatedly and context-dependently, ensuring participants understand the connection between their collected data and the purpose of the collection they are consenting to; (2) the researchers continually assess whether participation is voluntary; (3) the possibility to opt-out is discussed at different stages (Novitzky et al. 2015, 758). We have adopted a layered approach to information provision, which means that participants were able to receive more detailed information if so desired (see Meijering et al. 2020 for further details). Finally, a lay advisory group with lived experience has given advice as to how to recruit, approach and work with the participants. The Research Ethics Committee at the [anonymised for peer review] has approved the study and data have been stored and managed in line with the General Data Protection Regulation (GDPR).

4. Activity spaces, mobility, and activities across the seasons

4.1. Activity spaces in summer and winter

We included seventeen participants with different characteristics in terms of gender, age, living environment, experienced impairments and transport modes used (see Table 1). Overall, our participants perceived their mobility and quality of life as good, including those who experience impairments.

Figure 1 illustrates the size of activity spaces in summer and fall/winter for each participant. The results reveal a wide variation in activity space sizes both between participants and within the same participants across the two seasons, with varying degrees of spatial overlap between their activity spaces. Although the mean size of activity spaces is larger in fall/winter, no significant difference was found following a paired t-test that was conducted to compare the log-transformed values of activity space sizes in the summer (M = 19.00, SD = 1.62) and fall/winter (M = 19.65, SD = 2.04); t(16) = −1.162, p = 0.262.

We zoom in to the activity spaces of one of our participants, Mr. Peeters, to get more detailed insight into activity spaces at the individual level. Figure 2 visualises the overlap in his daily activity spaces, which can be explained with the information obtained through the activity diaries and in-depth interviews. In summer, he made one trip to visit his son, which is represented by the large light-blue area on the bottom-left. The ellipse on the lower right of both figures represents visits to a family member for whom he provides informal care. When zooming in to the activity spaces close to his home, there is a small space close to the home that he frequents on a daily basis, which is his allotment located at cycling distance in the village where he lives. In the fall/winter, the area that he frequents at least four times a week is larger than that in summer, and covers a variety of shops, services and social contacts in and around the village. Modelling activity spaces in this way helps to distinguish between daily and more incidental activity spaces.
4.2. Modes of transport in summer and winter

We used the activity diaries to establish how often different modes of transport were used in the different seasons (see Table 2). Overall, fewer trips were registered in the summer than in fall/winter. This could be related to the fact that some participants adapted their behaviour in light of the COVID-19 situation (see also Osborne and Meijering 2023). Also, our participants may have combined more destinations in one trip in the summertime. Both active and motorised modes of transportation were used less in summer, but the difference is larger for motorised

<table>
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<th>Pseudonym</th>
<th>Age range</th>
<th>Marital status</th>
<th>Living environment</th>
<th>House type</th>
<th>Outdoor space</th>
<th>Impairment</th>
<th>Mobility aid</th>
<th>Transport modes</th>
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<td>Cognitive</td>
<td>Peroneal spring spring</td>
<td>Car, E-bike, Car, Bicycle, E-bike</td>
</tr>
<tr>
<td>14</td>
<td>Mrs. Pietersen</td>
<td>71–75</td>
<td>Widowed</td>
<td>Rural</td>
<td>Apartment</td>
<td>Balcony</td>
<td>Cognitive</td>
<td>Walker</td>
<td>Car, E-bike, Car, Bicycle, E-bike</td>
</tr>
<tr>
<td>15</td>
<td>Mr. Pakvis</td>
<td>71–75</td>
<td>Widowed</td>
<td>Rural</td>
<td>Detached</td>
<td>Garden</td>
<td>Physical and cognitive</td>
<td>None</td>
<td>Walk, Bicycle, E-bike, Car, E-bike</td>
</tr>
<tr>
<td>16</td>
<td>Mrs. Van Wijk</td>
<td>61–65</td>
<td>Single</td>
<td>Town</td>
<td>Detached</td>
<td>Garden</td>
<td>Physical and cognitive</td>
<td>Walker</td>
<td>Walk, E-bike, Car, Bicycle, E-bike</td>
</tr>
<tr>
<td>17</td>
<td>Mrs. Froolik</td>
<td>71–75</td>
<td>Married</td>
<td>Rural</td>
<td>Detached</td>
<td>Garden</td>
<td>None</td>
<td>None</td>
<td>Walk, Bicycle, Public transport, Car</td>
</tr>
</tbody>
</table>

*All participants had retired, except those three marked with an asterisk.

4.2. Modes of transport in summer and winter

We used the activity diaries to establish how often different modes of transport were used in the different seasons (see Table 2). Overall, fewer trips were registered in the summer than in fall/winter. This could be related to the fact that some participants adapted their behaviour in light of the COVID-19 situation (see also Osborne and Meijering 2023). Also, our participants may have combined more destinations in one trip in the summertime. Both active and motorised modes of transportation were used less in summer, but the difference is larger for motorised
transport, which aligns with our expectations. However, we could not observe an increase in other transport modes to compensate for this. Zooming in further, the amount of trips by bicycle was approximately the same, and walking was used slightly less in summer, which was contrary to our expectations.

Figure 1. Activity spaces of all participants differentiated by summer and fall/winter.
4.3. Activities in summer and winter

We used the activity diaries to establish the amount and type of activities that our participants undertook in the different seasons (see Table 3; for the categorization see Nordbakke and Schwanen 2015; Sattari, Weitkamp, and Meijering 2023). Our participants in general undertook slightly more activities in summer than in fall/winter. The difference is most pronounced for socialising, and fitness and exercise. In contrast, the participants engaged in fewer shopping, work-related and healthcare activities. Other categories of activities, such as errands and chores, are constant in number. These include routine activities such as grooming, and household work. There is likely to be a ‘holiday effect’ for work-related activities, since some of the data collection took place in July and August. Also, we assume that there are some effects of the COVID-19 pandemic with regard to shopping, socializing and recreation in particular.

We now zoom further into the categories of socialising, recreation and entertainment, and fitness and exercise activities. In terms of social activities, it was remarkable that participants recorded more social phone calls as well as interactions via Whatsapp with family and friends, and slightly fewer face-to-face meetings in summer. This is likely a pandemic effect. Also,
participants mentioned more often that they would meet family and friends outdoors, as a precaution against a COVID-19 infection, which was feasible in the summertime. As depicted in Figure 3, the majority of social activities outside the home were conducted during the afternoon, regardless of the season. In contrast, relatively few social activities occurred during the evening, both in fall/winter and summertime. In part, this can be related to daylight, which we discuss in Section 5.1.

Recreation and entertainment is a substantial category. What was striking overall, was the little variation in times that activities such as reading, watching TV, and reading the newspaper were reported in both seasons. What was remarkable is that this runs counter participants’ experiences: many told us that they would engage less often in activities such as watching TV in summer, as is illustrated with the following quote:

We enjoy watching detectives […] and we record them. You don’t watch them straight away, because otherwise you’re always sitting in front of the television […] From time to time, we watch a series. We’re well-behaved, so no binge watching, but nicely divided over a couple of days we finish watching a series. But in general you can say that we watch less television in summer than in winter. Since in the wintertime, I sometimes switch it on at 6PM to watch the news. (Mr. Peeters, summer)

Mr. Peeters explained that he watches more TV in winter, since he engages in fewer outdoor activities. Other participants shared similar stories, but this was not evidenced from the data in the activity diaries.
With regard to fitness and exercise, the patterns in Figure 4 show that participants engage more in this activity in summer than in fall/winter, more or less across time of the day and week. These are more in line with our participants’ experiences. They reported engaging more in hiking and cycling for fun in summer than in winter, which they explain by the fact that the weather is typically nicer in summer.

One major exercise that participants reported doing in summer, and not in fall and winter, is gardening. For instance, Mr. Willems, who has a sizeable garden, explained how gardening contributed to spending more time outdoors:

In the wintertime, I spend less time outdoors. There’s no work to be done in the garden. Gardening is a physical activity too. I have a lot of hedges that all need trimming in summer. It took me two days to trim all the hedges. It’s pretty intensive work, which does not happen during winter. (Mr. Willems, summer)

Mr. Willems is an exceptional case in the sense that the size of his garden is larger than that of most other participants, and thus the amount of work that he has to put on is more significant as well. However, in the overall patterns, gardening did emerge as an activity that is carried out in summer, and not in fall/winter. In contrast, our participants reported fewer organised sports activities in summer than in winter. It seems that these organised activities are at least in part compensated for by hiking, cycling and gardening.

5. Seasonal and weather influences on activities and mobility

5.1. Daylight hours

When looking further into the seasonal influences on activities and mobility, the variation in daylight time across the year arose as relevant. The mean distance of trips during the day \(N = 803\) was significantly shorter than the mean distance of trips after sunset \(N = 142\). An independent sample t-test revealed that the means of the trip length in kilometres during daylight \((M = 9.24; SD = 17.92)\) and after sunset \((M = 23.2; SD = 42.96)\) were significantly different: \(t(943) = -6.54, \)
The spatial data suggest that after sunset, participants engage relatively often in planned activities that are located far from the home. However, our participants explained the patterns in their activities during daylight and darkness in a different way. For instance, several participants told us how they are reluctant to go out when it is dark, including Mr. de Graaf:

Yes, in general I don’t go out late at night, not in the evenings in general. I'm a bit night-blind, even when cycling. Generally, I don't leave the house at night. When you get older, you don’t have that many appointments in the evening or whatever, so that’s different anyway. Recently, when we went to see our former neighbours, we took the car. I remember the weather wasn’t great. But in summer, we would have gone by bike. (Mr. de Graaf, fall/winter)

Mr. de Graaf does not like to go out when it is dark because he cannot see well in the darkness. He also explained that he typically does not engage in night-time activities, which he relates to the life phase that he is in. Other participants explained they would perhaps not stay at home altogether, but choose a different transportation mode in different seasons. An example is Mrs. Blom who goes to a yoga class.

Mrs. Blom: [In winter] I usually take the car, in summer I go by bike. It’s around ten minutes by car, so around four kilometres, yes, three to four.

Interviewer: So in the wintertime in the evenings.

Mrs. Blom: Yes, then I think it’s too dark. […] I don’t like to cycle in the dark. (Mrs. Blom, fall/winter)

Mrs. Blom told us that she would go to her yoga class by car in the darker times of the year, and by bike in the summertime. However, when she participated in the data collection in the summertime again, she went to her yoga class twice in the recorded week, both times by car. Then, other reasons played a role, such as her having had a busy day and no time to cycle, or her feeling very tired. This example shows once more how activity and mobility patterns and experiences can be different, which was evident in other participants’ accounts as well.

Some participants made an explicit connection between the daylight hours and weather in different seasons and their general wellbeing. They reported feeling more ‘down’ during the darker times of the year, as a result of which they spent more time at home, engaging in relatively passive activities such as watching TV. Mr. Kuipers:

I can’t stand darkness and rain, the autumn-type weather. I’m not made for autumn. […] I always feel less positive in these periods, with it getting dark early, especially in combination with rain. Grey and rainy, I hate it. […] And when the weather is so bad, I don’t get out much. I just hang around in the house, and that doesn’t cheer me up either. (Mr. Kuipers, summer)

Mr. Kuipers’ story makes clear that short days, especially in combination with rain, have a negative impact on his well-being. In contrast, participants reported that they enjoyed being active in the summertime, in light of the nice weather and daylight. Mr Peeters told us:

Around half 7 I thought, yes I’m going to the allotment, the weather is so nice. And before you know it, it’s an hour later. So it was 20 to nine when I got back home. (Mr. Peeters, summer)

In the wintertime, Mr. Peeters stayed at home most evenings, while in the summer he often went to his allotment to do some gardening work. This is connected to the fact that gardening is a spring/summer activity, as well as the longer daylight hours and more pleasant weather. These stories about daylight are closely intertwined with general seasonal variations in weather.

5.2. The weather of the day

We indeed found that the weather of the day also impacts the activities that our participants undertake. Here, the role of rain and wind came to the fore in particular, since these weather circumstances may occur irrespective of which season it is in the Netherlands. The majority of our
participants underlined that they would not undertake certain activities if it rained or when the weather was stormy. An example is Mrs. Froolik:

When it rains, even if it's healthy, I don't go out [on my bike]. If it's windy, that's ok. [.] Then we check the direction that the wind is coming from, so we first cycle against the wind, that's more convenient. So in that sense the weather has an impact. (Mrs. Froolik, fall/winter)

As she explained, Mrs. Froolik does not go out on her bicycle if it rains; if that's the case she will wait for the weather to get better, or use another form of transport. When the wind is heavy, she may also be deterred from cycling, although there she does use the strategy of starting against the wind in case of recreational cycling. Other participants shared similar considerations, and their freedom to adapt their activities to the weather can be related to the fact that they are almost all retired. Although most participants would not leave on foot or bicycle if it rained, they accepted the possibility of being caught in a rainshower, such as Mrs. Pietersen:

I cycled through the tunnel there [while discussing the maps with GPS-data], I went through the tunnel there, and then it was raining. [ … ] Then it started to rain cats and dogs and I had some liquorice in my pannier. They [two couples sheltering from the rain] had some liquorice and we chatted about all sorts of things. [ … ] Obviously, I don't leave to go cycling when it rains. But the possibility of a rain shower is always there [ … ] Then you just have to push through. (Mrs. Pietersen, summer)

Mrs. Pietersen did not like to cycle through the rain, but she also did not really mind if she got caught in a rainstorm. She would either seek a place to shelter, or put on her rain gear and cycle through the rain, and make the best of each situation, as the quote shows.

In contrast with the participants who adapted their activities to the weather, there were a few car-dependent participants such as Mr. Kraima and Mr. Remmers. As a result, they go out no matter what weather or seasonal circumstances, except perhaps glazed frost and their activity space is hardly impacted by the weather. Typically, these were also participants who also experienced physical impairments that made walking and/or cycling difficult. Finally, we had one exceptional participant who would also go out regardless which weather it was:

I have a good sailing jacket with a hoodie, and whether it rains or not, I don't care. [ … ] When I go into the forest, I put a belt with a lamp around my waist and when I can't see [makes a clicking noise] I turn it on. So then it's fine. [ … ] And I walk with sticks, I use them to gauge, you learn by doing right? (Mr. Pakvis, fall/winter)

Mr. Pakvis is exceptional in the sense that he does go out, no matter what weather or time of the day it is. He lives close to a nature area that he likes to walk in during the different seasons, and at different times of the day including early mornings and late evenings. When it is dark, he uses a lamp, and when it rains, he wears his rain gear. He feels that staying active has a positive impact on both his physical and mental health.

Overall, participants experienced the weather in summer as more conducive for outdoor activities, in light of the longer daylight hours, and temperatures and weather conditions that they experienced as more pleasant. Although these experiences are partly corroborated by the spatial data, they indicate that the impact of the weather on activities is smaller than the participants’ narratives suggest. Figure 5 shows the differences of activity spaces visited during good and bad weather conditions. Good weather conditions are defined when temperatures are between 10 and 25 degrees Celsius, wind speed is lower than 8 metre/second, and there is less than 1 mm of rain. As anticipated, most activities during good weather conditions occurred during summer, whereas activities during bad weather conditions were more likely to take place during fall/winter. The sizes of the activity spaces during good weather are therefore larger during summer than during fall/winter. However, participants were not deterred from engaging in out-of-home activities during unfavourable weather conditions; the total number of trips during good and bad weather were 421 and 525, respectively.
5. Discussion and conclusion

With this article, we have explored the seasonal differences and similarities in mobility and activity space in later life in the Northern Netherlands. Our main finding is that it is the combination of seasonal factors such as length of day and weather factors such as rain and sunshine that explains differences in mobility and activity space of older adults. Seasonal factors and the day's weather also have separate impacts on everyday mobility and activity space, with darkness, rain, wind and heat being the most important factors. Furthermore, the intersection with individual characteristics, such as experienced physical and cognitive impairments, living environment as well as personal preferences for and against activities and modes of transportation plays a key role. This latter aspect contrasts with earlier research, which has underlined the significant intra-personal variation in mobility (Raux, Ma, and Cornelis 2016).

Zooming in to our findings, we see that activity spaces are typically slightly larger in fall and wintertime. Although perhaps counterintuitive, this can be explained by the fact that car usage is higher in these seasons, enabling older adults to cover larger distances. These findings resonate with earlier work which has outlined the largely negative impact of extreme seasonal circumstances such as snow and ice (Finlay 2018) and heat (Böcker, van Amen, and Helbich 2017) on active transportation in later life. Since active transportation is typically carried out over short distances, it is possible that in adverse weather circumstances, activity spaces are actually larger. However, this does contrast with Portegijs et al. (2014) work on older adult mobility in Finland who found that activity spaces are larger in spring than in winter.

With regard to the type of activities that older adults undertake in different seasons, the most striking findings are that they socialise and exercise more in the summer than in fall/winter. This is in line with what we expected, and can be explained by the fact that older adults feel more motivated to go out and walk or cycle in light of the more pleasant temperatures and longer days, as well as by the seasonal nature of activities such as gardening. The social nature of cycling has also been alluded to in our findings, and could be worth investigating in more depth in relation to the emotions in and of moving (Mclvenny 2015). Walking and cycling are important forms of physical activity in later life, which has been confirmed in other research (Van Cauwenberg et al. 2012). They also found that walking and cycling are limited through feelings of unsafety, which could be related with time of day and darkness in particular. Slightly different from earlier work, we found that participants make relatively long trips when it is dark, which suggests that these activities have been planned. This contrasts with the experiences of some participants who say they avoid going out when it is dark. Further research should consider daylight and the association with observed and perceived activity type and mode of transportation in more detail. Also, we found that what people say they do is not always at odds with what they actually do, for instance with regard to going out in the dark, and self-reported activities. It
would be valuable to look further into the discrepancies between what people say they do in in-
depth interviews, and what is recorded with GPS and activity diaries.

Although this study has contributed towards explaining the variation in mobility over time,
further research is needed to better understand the factors that explain sequences of (non)move-
ment and (in)activity over the course of smaller timescales such as the day and the week. For
instance, cycling to the supermarket in an autumn storm in the morning may result in less activ-
ity and movement during the rest of the day. Although our research provides some pointers for
this, other more precise methods such as Ecological Momentary Assessment (EMA) would enable
uncovering these relations (see Kwan 2012). Such research would strengthen understanding of
the relation between actual movement, motility and well-being (Cuignet et al. 2020).

Past research on weather has shown it to be a barrier to health care provision (Joseph,
Skinner, and Yantzi 2013), physical activity (Tucker and Gilliland 2007) and active travel (Böcker,
Dijst, and Prillwitz 2013). This work, however, has been argued to overlook the variety of experi-
ences elicited from the weather, such as its calming or challenging effects (Bell et al. 2015, Bell,
Leyshon, and Phoenix 2019). Coinciding with the discussions on the relational and more-than-
human influences of space encounter, such as non-human animals (Gorman 2017) and vegetal
geographies (Lawrence 2022), there has been a growing body of work unpacking and expanding
our understanding of the influence of weather-worlds in our everyday lives (see, for example,
Bell, Leyshon, and Phoenix 2019; Osborne 2022; Simpson 2019). Building on this work, we have
demonstrated how objectively and subjectively-measured weather-worlds can influence older
adult mobility and the activity spaces they inhabit. Further research could delve deeper into the
role of non-human actors in different weather circumstances (see Waight and Yin 2021).

Theoretically we have contributed to the concept of activity space as grounded in everyday
life and the broader socio-spatial context through our grounded visualisation approach, and thus
expanding discussions around mobility and time-geographies more broadly. Our work adds to
earlier conceptualisations of activity space, in general, also in relation to functional impairments
and (physical) activities (see, for example Kopec 1995; Smith, Foley, and Panter 2019).
Furthermore, our study confirms the predominantly monocentric nature of activity space in later
life (Hasanzadeh 2019; Hasanzadeh et al. 2021). Typically, the home is the place from which
activities are undertaken and other places visited. The activity spaces that we generated confirm
earlier work that has shown that residential buffers are not adequate to capture activity spaces
of older adults, as has been argued before (see, for example, Franke et al. 2017; Hirsch et al.
2016). Rather, the importance of modelling individual activity spaces has been underlined
(Ramezani et al. 2021). Our research builds on this by showing the season-specific nature of
activity space within individuals. Furthermore, our research has shown that it can be relevant to
distinguish daily and incidental activity spaces (see Sturge et al. 2021). This distinction gives
space to the complementary qualities of places (Qviström, Fridell, and Kärholm 2020). Finally,
in our study of mobility and activity space we have shown that results generated through different
methods can both confirm and complement each other, which is in line with earlier research
(Kestens et al. 2018). Further research could unpack these differences and similarities more, for
instance by looking at how specific weather circumstances such as wind direction and strength
impact individual activity patterns, and how these observed patterns are interlinked with peo-
ple’s experiences.

A strength of this research is its mixed-methods and grounded visualisation approach.
Through integrating spatial and qualitative data in an iterative process, we were able to come to
an in-depth understanding of the complexities around everyday mobility and activity space in
different seasonal and weather circumstances. However, there are also limitations to our study,
which include the relatively small and diverse nature of the sample of participants. This means
individual variation is substantial. For instance, we included participants who lived in different
places. As there is no (or little) overlap in their activity spaces, we cannot give area-specific
insights or recommendations. Furthermore, since we did not collect data from all participants

during the same weeks, there is some variation in weather conditions for the different participants. Finally, there is scope for further research into socio-spatial contexts as well as individual capabilities, such as in light of specific physical and cognitive impairments.

Our study combining seasonal and weather factors with mobility studies extends and challenges existing conceptualisations and measurements of mobility and activity space. Conceptually, we have developed discussions around the distinction between trips and activities in later life mobility, and the implications of the fact that older adults combine multiple activities in one trip. Furthermore, the distinction between daily and incidental activity spaces is important in light of seasonal factors. Our mixed-methods approach enabled us to uncover the discrepancies between perceived and measured mobility and activity space. Finally, our sometimes counterintuitive results, such as walking less in summer and having a larger activity space in winter, demonstrate that it is vital to remain cautious with regard to common assumptions around mobility in later life.

Since going out and engaging in activities is related to well-being in later life, our study has implications for health research and practice. It fits with the growing body of research that seeks to connect activity space to health research (Naud et al. 2020; Perchoux, Chaix, and Kestens 2019; Sturge et al. 2021). With the continued concerns around our environment due to climate change, it is paramount that we continue to explore the impacts of seasonal and weather contexts on mobility practices and health and wellbeing of the population in general and older adults in particular. Indeed, this paper provides nuanced understandings that could have implications for the planning of age-inclusive future environments to ensure that older adults can age healthily and well.

Note
1. The section on study context is partly reproduced from Meijering and Weitkamp (2023).

Disclosure statement
No potential conflict of interest was reported by the author(s).

References


