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Bringing the "Place" to Life-Space in Gerontology Research

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Keywords

Life-space · Activity space · Global positioning system · Older adults · Place

Abstract

Understanding older adults' relationships with their environments and the way this relationship evolves over time have been increasingly acknowledged in gerontological research. This relationship is often measured in terms of life-space, defined as the spatial area through which a person moves within a specific period of time. Life-space is traditionally reported using questionnaires or travel diaries and is, thus, subject to inaccuracies. More recently, studies are using a global positioning system to accurately measure life-space. Although life-space provides useful insights into older adults' relationships with their environment, it does not capture the inherent complexities of environmental exposures. In the fields of travel behaviour and health geography, a substantial amount of research has looked at people's spatial behaviour using the notion of "Activity Space," allowing for increasing sophistication in understanding older adults' experience of their environment. This manuscript discusses developments and directions for extending the life-space framework in environmental gerontology by drawing on the advancements in the activity space framework.

Introduction

In the past 2 centuries, we have witnessed a demographic shift: the global population has been ageing at an unprecedented rate. With the growing number of older adults, the notion of healthy ageing, defined as "development and maintenance of optimal physical, mental, and social well-being and function in older adults," is receiving increasing attention [1]. This has become even more relevant during the COVID-19 pandemic because older adults are being disproportionately affected by this virus. In fact, the COVID-19 pandemic has further emphasized the need to support healthy ageing and to prevent age-related diseases as a whole. An important determinant of health amongst older adults is outdoor mobility. Unfortunately, with increasing age, declines in physical and cognitive functions become more prevalent and lead to growing mobility challenges. Furthermore, in the course of this pandemic, older adults' daily mobility patterns are being extremely affected by government recommendations for self-isolation and physical distancing [2]. Mobility limitations in the older population result in many adverse outcomes including declines in psychological and physical health [3]. Given the importance of maintaining outdoor mobility on the quality of lives of older adults, there is an increased need for characterizing and measuring this important dimension of mobility. This "environmental turn" in gerontology research has given rise to

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several studies looking at older adults' relationships with their environments. A common framework used to evaluate this relationship is "life-space," which refers to the geographical area through which a person moves within a specific period of time [4]. The life-space framework not only provides insight into a person's level of engagement with the environment but also is an important indicator of older adults' physical health, cognitive health, and mental well-being [5].

Parallel to the research on life-space in environmental gerontology, a substantial amount of applied research has focused on the quantitative analysis of people's spatial behaviour using the notion of "Activity Space" in the fields of travel behaviour and health geography. Activity spaces are defined as the locations "within which an individual has direct contact as a result of his or her day-to-day activities" [6]. Therefore, in addition to measuring the geographic extent in which people move, which is also captured by life-space, activity space considers the geographies of places that people visit in the course of their daily activity. Activity space has been used widely in disciplines such as epidemiology, public health, and urban and transportation planning, which attests to its usefulness [7]. However, despite its relevance for assessing environmental exposure and outdoor mobility, the activity space concept is almost absent from environmental gerontology studies and needs to be further explored. Given the context outlined above, the purpose of this manuscript is to take advantage of the activity space framework in travel behaviour and health geography literature to further explore new methods for studying the dynamics between community-dwelling older people and their outdoor living environment.

Life-Space Concept

The term "life-space" was first introduced by May et al. [4] to define the indoor and outdoor geographies through which a person moves within a specific period of time. They divided life-space into 5 concentric zones beginning with the bedroom at the centre and then extending to increasingly larger areas including the rest of the home, the grounds surrounding the home, the neighbourhood block, and the area across a traffic-bearing street. To measure life-space, May et al. [4] introduced the "life-space diary," which was a table with these 5 zones listed in the first column, and 31 subsequent columns each representing a day in the month. Participants using a diary are instructed to indicate the zones they had moved through during a day, over a 1 month period. To quantify the extent of a person's mobility over the diary period, entries are converted to a life-space diameter score. Higher life-space scores are strongly associated with better performance measures like gait speed and balance [4].

While May et al.'s [4] life-space diary provided a useful assessment of mobility in areas immediately around the home, it was not appropriate for community-dwelling older adults with more frequent excursions beyond the immediate home environment. Stalvey et al. [8] introduced a means to measure the mobility of community-dwelling older adults with the Life Space Questionnaire (LSQ), which covered a broader range of environmental zones and reduced the burden on participants by eliminating the month-long diary. Like the life-space diary, LSQ scores are associated with important outcomes including mental health and cognition. For example, smaller LSQ scores are linked with higher rates of depressive symptoms and impaired cognition [8, 9]. Building on the LSQ, the University of Alabama at Birmingham (UAB) Study of Ageing Life-Space Assessment (LSA) introduced a new measure that considered not only the extent of movement in the environment but also the frequency of movement and any assistance needed [10]. The LSA involved a single interview in which participants recalled their mobility during the previous month. Higher LSA scores are associated with higher physical performance and lower risk of depression [11].

More recently, studies have begun using global positioning system (GPS) enabled devices to accurately monitor and measure life-space. These studies have used GPS data either to divide the environment into zones and derive a score consistent with the LSA score [12] or to calculate geographic indicators that describe an individual's daily activities. Commonly used indicators include the area of an ellipse covering all the GPS coordinates tracked, total distance travelled, and the maximum distance travelled from home [13]. While most studies in environmental gerontology rely on multiple GPS-based indicators to measure life-space, there has been an increasing emphasis on extending the definition of life-space to reflect the multidimensional nature of mobility. Despite the increasing use of GPS data in this domain to capture more nuanced measures of life-space, there have been few attempts to establish a classification framework that groups and characterizes a wide range of GPS-based indicators for this literature [14].

Activity Space Concept

The activity space framework is closely related to the life-space framework and was developed in parallel in fields like public health, urban planning, geography, and transportation. The spatial structure of activity spaces is less structured but can generally be organized into 3 primary classes: (1) home and movements around the home; (2) daily activity locations and movements around those locations; and (3) movement and trips between the daily activity locations [6]. Furthermore, the temporal structure of an activity space can be characterized by 3 features: the frequency, regularity, and duration at which locations are visited [15].

Activity spaces are commonly described using 5 primary approaches: ellipse-form, network-based, kernel density, minimum convex-hull polygons (MCPs), and activity locations [7]. Ellipse-form approaches use different types of ellipses to describe activity spaces. A commonly used ellipse-form is the standard-deviational ellipse, whose major and minor axes refer to the maximum and minimum directional standard deviations, respectively [7, 16]. Network-based approaches are built upon the idea that people's activity spaces are not only related to their actual movements through space but also constrained by their transportation networks [7, 17]. In this approach, activity spaces are described as networks with the locations in which activities occur as nodes and the paths between these locations as edges constrained to transport infrastructure [18]. Additionally, activity spaces are also described using kernel density estimation, which is a data smoothing technique that interpolates location points to a continuous surface. To characterize activity spaces using this approach, the value of a kernel density estimation surface at a specific point is determined by the frequency of and distance to other nearby recorded points, with higher values indicating more "presence" at a location [19]. Another commonly used approach is MCP, which is the smallest convex polygon encompassing a set of data points. To describe activity space in this model, the data points are typically considered to be activity locations (i.e., destinations), while the MCP represents a spatial range [20]. The last approach is referred to as activity locations, in which activity spaces are described solely by the specific locations at which activities that take a predetermined amount of time have taken place (e.g., all stops of 10 min or greater) [21].

In the fields of travel behaviour and health geography, the activity space framework has been widely applied. For example, there have been several studies whose main objective is to assess the environmental and individual-level factors affecting the geography and temporal characteristics of activity spaces [22, 23]. In one study, Villanueva et al. [23] examined the effects of sociodemographic characteristics on activity spaces and found that children in schools located in more walkable neighbourhoods had larger activity spaces compared to other children, but girls displayed reduced activity spaces if they lived on a busy road. Another important area where activity spaces have been deployed is in exploring access or exposure to locations associated with either positive or negative health, economic, or social outcomes [16, 24, 25]. Widener et al. [24] provide an example of this approach when they measured activity spaces to understand how daily movement patterns impacted access to different types of food retail. Finally, a large number of studies have applied activity spaces to evaluate social exclusion and segregation [18, 26, 27]. For instance, Vallée et al. [26] assessed the relationship between activity spaces and depression, and the effects of neighbourhood deprivation.

Life-Space: An Inadequate Measure to Assess Outdoor Mobility Dynamics of Older Adults

Now that GPS technology is being increasingly used to measure life-space, it is important to consider how the development and application of the related activity space framework may contribute to and complement life-space methods in the evaluation of mobility in gerontology research. The construct of life-space focuses on the extent of travels into the environment. As a result, studies that use life-space to look at the relationships between outdoor environments and various health behaviours for older adults, only examine the change in the spatial size of life-space and are potentially ignoring valuable information about activities and behaviours occurring beyond the home. For instance, one study demonstrated that a reduced life-space area is associated with a higher prevalence of depressive symptoms [5]. However, what are the mechanisms and geographic contexts that led to such a finding? Although generally a larger space can result in improved health outcomes, it is important to consider that the size of life-space is a function of the general built environment in which it is embedded. For older adults, a smaller life-space in a dense age-friendly environment may be preferable compared to a larger life-space in a car-oriented suburban region. To make this distinction, it is important to move away from relying upon the size of life-spaces and towards life-space metrics that capture important variables that enable older adults to engage in health-promoting trips and activities. As such, the activity space framework may provide a useful construct for describing the spatial behaviour of older adults by capturing the inherent complexities of engaging with the built environment.

The extensive literature using activity spaces complements the home-focus of life-space analysis by also integrating a person's daily trips and activity locations. The emphasis on the variations in places frequented by a person provides important context about the type of places and the features in the built environment that can be relevant to health behaviours and outcomes. For instance, participation in cognitively demanding activities such as going to a bank or physically demanding activities such as going to the gym can inform us about the cognitive or physical status of an individual.

Furthermore, the notion of life-space has traditionally been characterized by looking at the frequency of excursions into fixed zones centred on one's home and devoid of geographic context. The boundaries of these zones are defined by predefined distance thresholds, which have conceptual limitations. The choice of the thresholds should be specific to an individual rather than widely applied to study participants in varying geographical locations, as older adults' travel behaviour is known to vary substantially by the local built environment [28]. Additionally, as is done in activity space analysis, life-space should not be considered isotropic; that is, the shape of life-space should be distorted in certain directions according to the most important places (e.g., shops and transport stations) [15]. To address these limitations, we can apply network-based approaches introduced in previous activity space research, like a useful analysis method developed by Flamm and Kaufmann [17], known as the "Personal Network of Usual Places" tool, to assess environmental exposure. Using approaches like this, it will be possible to extend the life-space construct by incorporating not only the residential areas (i.e., "daily life centres") but also other activity locations (i.e., places) and transportations between these locations.

Conclusion

The potential adoption of an activity space framework, attention to contextual information and the definition of place, and considering various distance thresholds that define life-space zones are all important to further enrich and refine the concept of life-space in environmental gerontology. To do this, researchers in this domain should consider the work being done in cognate fields that commonly deal with movement and the impact of location. Modelling the behaviour of older adults is a complex endeavour, and complementing our field's current approaches with these new ideas will lead to new insights in the impact of lived environments on mobility, health, and social connection.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

S.B. and M.W. were involved in generating and researching the commentary topic of interest and performed the literature search. S.B. drafted the manuscript. M.W. and A.M. provided suggestions and edits to improve the manuscript.

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