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ID 1489 | URBAN GREEN SPACE AND THEIR IMPACTS ON PHYSICAL ACTIVITY LEVELS OF OLDER PEOPLE: EXPLORING APPROPRIATE METHODOLOGIES

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1 INTRODUCTION

Extended life expectancy and the decrease in the birth rate have led to a global concern of population ageing (Garin et al., 2014) and is resulting in increasing pressures on public health expenditure. Evidence has shown that physical inactivity among older adults is associated with higher mortality, morbidity and an increased burden of non-communicable diseases (NCDs) worldwide (Adams et al., 2014; Arango et al., 2013; Woodcock et al., 2011). Although regular physical activity (PA) brings health benefits, there are high levels of physical inactivity within the general population. Worldwide, 31.1% adults are physical inactive (Hallal et al., 2012), in terms of older adults (aged 60 years and above) the proportion meeting physical activity guidelines ranged from 2.4 to 83.0% in a review of fifty three studies (Sun et al., 2013). In Europe, it was found that 60–70% of older adults fail to meet physical activity guidelines (Eurobarometer, 2010). Low levels of physical activity of older adults is clearly a very substantial public health challenge.

There is a growing body of research that examines the relationship between the built environment and physical activity (Handy et al., 2002; Nagel et al., 2008; Rech et al., 2012). It is widely recognized that physical activity is affected by a wide variety of built environment-related attributes, including street connectivity, residential density, land-use mix (Clifton et al., 2009; Lawrence D. Frank et al., 2005) as well as sidewalks, trails, recreational facilities, parks (Ferdinand et al., 2012), traffic density and speed, crime and safety and so on. (Ferdinand et al., 2012; Prezza et al., 2001). Besides, Physical activity can be categorized into four domains, including transportation, recreation, household and occupation, and each of these are influenced by different aspects of the built environment. For example, PA in the household and occupation domains appears to be less related to the relationships with the built environment (Van Cauwenberg et al., 2011), but transport and recreation offer key opportunities for interventions to promote health. This is critical for older adults who are more likely to suffer from a decrease in physical functions, and thus they are more vulnerable to be impacted by built environment barriers towards PA (Forsyth et al., 2009; Rantakokko et al., 2009). However, there is limited research focused on this specific demographic group (Van Cauwenberg et al., 2011; Cunningham and Michael, 2004). Therefore, it is imperative to enhance our understanding on the relationship between the built environment and physical activity, to identify opportunities to improve the physical activity levels of older adults, as a strategy to help reduce in social and health care.

The built environment is a very broad and complex concept, among all environmental settings, urban green space (UGS) appears to play a prominent role in facilitating PA. UGS is defined as “all publicly owned and publicly accessible open space with a high degree of cover by vegetation, e.g., parks, woodlands, nature areas, and other green space within the city boundary” (Schipperijn et al., 2013, page 110). UGS provides important settings for physical activity at low cost, especially for leisure-time activities like walking and cycling (Veitch et al., 2012), and for generating wider psychological, physiological, social and economic benefits (Hunter et al., 2015; Veitch et al., 2014). The availability and accessibility of UGS appear to be closely related to increased levels of physical activity (Hunter et al., 2015; Schipperijn et al., 2013), which offers important opportunities to improve the physical activity levels of older adults. Recent studies show that higher levels of physical activity are frequently related to urban green attributes, including proximity (Kaczynski et al., 2009, 2014), size and design features (Kaczynski et al., 2008), walking/cycling paths, wooded areas, open spaces, water features, lighting, pleasant views, bike racks, parking lots, and playgrounds (Schipperijn et al., 2013). However, there are still inconsistences in this research field. For example, a research by Hillsdon et al. (2006) has found no significant relationship between access to urban green space and physical activity in recreational physical activity domains, contrary to some other studies. In another review of sixty papers, discrepancies existed cross studies addressing the relationship between greenspace and obesityrelated health issues (Lachowycz and Jones, 2011). A combination of conceptual and methodological issues may help explain for the mixed results among studies (Koohsari et al., 2015).

The fact that most research has been undertaken in the US and Australia (Hunter et al., 2015), may also explain some anomalies, so it is important to conduct further research in other parts of the world. Different counties may vary in urban morphology, street layout, population density, climates and socioeconomic status. Thus, research results and recommendations for the US or Australian cities may not be directly adapted to other contexts, such as European cities nor any other developed countries (Schipperijn et al., 2013).

Furthermore, a large body of research showed that the usage of urban green space engaged with physical activity is less desirable (Cohen et al., 2010; Edwards et al., 2015; Lackey and Kaczynski, 2009; Veitch et al., 2015). Most research is also cross-sectional and observational. Therefore, there is a need for further studies to identify the relationship between urban green space and physical activity, for older adults in European contexts and for this to be used to develop more effective strategies and recommendations to policy-makers, and other stakeholders.

This work examines this issue by focusing on the special role of urban green space and by reviewing the different methodologies that can be used to understand built environment influences on older people’s PA. To do this, we first review the ways of measuring PA in older adults, this is followed by considering the role of urban green space and finally suggests a research design for exploring this issue, using a case study from Belfast in the UK.

2 A REVIEW OF CURRENT METHODOLOGICAL APPROACHES

2.1 MEASUREMENTS OF PHYSICAL ACTIVITY LEVELS

A key element in evaluating built environment influence on PA is to gather accurate data on PA itself. Physical activity can be measured through a wide variety of methods, including self-report questionnaires, activity dairies, heart rate monitors, accelerometers, pedometers, and doubly labeled water (Prince et al., 2008; Sallis and Saelens, 2000; Sirard and Pate, 2001; Troiano et al., 2008). Indeed, there is a much greater body of research that has focused on children, adolescent and adults (Armstrong and Welsman, 2006; Baquet et al., 2007; Kohl et al., 2000; Sirard and Pate, 2001; Trost et al., 2000, 2002; Welk et al., 2000), compared to those over 60 years. Therefore, identifying reliable and validated measurements of physical activity for older people requires further evaluation.

2.1.1 SELF-REPORT MEASURES OF PHYSICAL ACTIVITY

Self-reporting is defined as self- administered or interviewer-administered questionnaires, activity logs or diaries, and for young children, proxy reports (Sallis and Saelens, 2000). Self-report measures are widely used and are a convenient way to assess physical activity. These are relatively simple to conduct and can gather data on domain-specific physical activity behaviors from a large number of people at low cost (e.g. i.e. older adults are walking for leisure or walking for transportation), but the overall daily physical activity patterns might not be accurately developed (Davis and Fox, 2007; Murphy, 2009).

Several self-reported physical activity questionnaires have been tested with adequate validity and reliability. An international reliability and validity study on International Physical Activity Questionnaire (IPAQ) was conducted by Craig and his colleagues in 14 centers in 12 countries during 2000 (Craig et al., 2003). This study concluded that IPAQ is a reliable instrument that can be used to assess the physical activity of a wide variety of demographic groups (18-65 years old) in diverse settings. Another physical activity questionnaire ¾ Global Physical Activity Questionnaire (GPAQ), was further developed from IPAQ showed content reliability and validity in a study carried out by Bull et al., (2009) in nine countries, suggesting that GPAQ is a reasonable instrument to monitor physical activity on general population worldwide. Age-neutral physical activity questionnaires such as IPAQ and GPAQ are widely used worldwide on large samples, as they are easy to conduct and require low budget. However, most age-neutral questionnaires focus on sport and recreational activity which has been shown only account for a relatively small proportion of older adults' daily physical activity (Washburn, 2015). Older adults tend to engage in more moderate intensity activities such as walking, and household activities such as gardening, with less sport and exercise (Davis and Fox, 2007). Therefore, physical activity questionnaires that are designed for general population may be less precise with older adults. In this case, some physical activity questionnaires have been intentionally developed for older adults, including Community Healthy Activities Model Program for Seniors (CHAMPS) (Carlson et al., 2012; Lim et al., 2005; Nathan et al., 2014; Td et al., 2006), Yale Physical Activity Questionnaire (Dipietro et al., 1993), Modi Wed Baecke Questionnaire for Older Adults (Voorrips et al., 1991) and the Physical Activity Scale for the Elderly (Washburn RA, 1999). These also provide good reliability and validity and have been employed in a large number of studies focusing on older adults (Washburn et al., 1993; Washburn, 2015; Washburn, 1999). Questionnaires that are exclusive for older adults are expected to provide more precise and valid outcomes than the age-neutral ones (Harada et al., 2001). Thus, it is higher recommended to employ questionnaires that are specifically designed for older adults.

However, self-report measures have inherent limitations, which have been widely discussed among researchers, demonstrating concern over the accuracy of self-report data on physical activity. Key issues here include social desirability bias resulting in over-reporting of physical activity (Warnecke et al., 1997), and recall bias, which may be a challenge when working with older adults. Recalling physical activity requires higher levels of cognitive ability and memory, while older adults are more likely to have poor memory and lower cognitive ability (Murphy, 2009; Sallis and Saelens, 2000). Moreover, fluctuations in physical and mental health may also reduce the accuracy of self-report (Rikli, 2000). Sallis (2000) pointed out that other selfreport instruments like activity logs and diaries also have limitations as well, they are limited by response rates and how much do participants could follow instructions. To overcome these limitations, objective measures such as accelerometers are increasing used in studies, with a key drawback of not being able to provide information on domain-specific activities.

In sum, it appears that self-report measures have specific advantages in obtaining information on the proportion of exercise achieved by different domains of physical activity and how these may be broadly related to relevant environmental settings. Self-report measures do have value in the role of clarifying the relationship between physical activity and the built environment of older adults, but if accurate amounts of physical activity need to be recorded, objective methods should be employed to increase the reliability and validity of physical activity data.

2.1.2 OBJECTIVE MEASURES OF PHYSICAL ACTIVITY

Objective measurements of physical activity are increasingly used to overcome the limitations of self-report measures. This has included the use of heart rate monitors, activity monitors and doubly labeled water. These can be complementary to self-report measures, and a combination of the two types of measurements can obtain even more accurate data on the patterns and amount of physical activity.

HEART RATE MONITORS

Heart rate monitors are primarily used for estimating approximate energy expenditure during PA. It has been demonstrated that heart rate is correlated with VO2 1and energy expenditure during physical activity (Welk et al., 2000). However, numerous factors can influence the accuracy of data collected using heart rate monitors. Melanson (1996) pointed out that other factors such as caffeine or stress can increase heart rate. In terms of older adults, they are more likely to take medication that may influence cardiovascular function, during resting and exercise (Rikli, 2000). Furthermore, in a study focusing on children, it was suggested that under active conditions heart rate outcomes were more significantly associated with direct observation measures compared with inactive conditions, this may result in an error of mean heart rate (Welk and Corbin, 1995). It I s widely recognized that older adults undertake different types of PA compared to young people who are more likely to participate in higher intensity physical activities for longer time. Older adults tend to engage more in moderate intensity physical activity like walking and household physical activities. Thus, it is logical to assume that the same errors may occur when researching PA in older adults. It has been suggested that heart rate monitors can be combined with motion sensing devices to reach a higher accuracy for data collection (Welk et al., 2000).

DOUBLY-LABELED WATER

Double-labeled water measurement is widely considered as a “gold standard” to measure accurate energy expenditure over time, both for lab and field-based studies on physical activity. It is a method that tracks carbon dioxide produced from metabolism to detect energy expenditure, using specific isotopes in labeled water (Murphy, 2009; Welk et al., 2000). However, this tends to be expensive and requires specialized expertise, so is not an ideal method for studies in larger field and epidemiological areas (Murphy, 2009). With respect to the older population, this technique may also be problematic in relation to older adults as some medication could impact water retention, or seniors may have medical conditions that influence the circulatory system conditions could also confound the accuracy of this technique (Rikli, 2000).

PEDOMETERS

Pedometers are instruments that can provide objective information on step counts, and they are less expensive than many other techniques such as accelerometer or doubly-labeled water, but have advantages and disadvantages similar to other motion sensors. They are easy to use but with less accuracy and precision. Lacking sampling abilities, pedometers do not provide detailed information on frequency or intensity of physical activity, so they cannot detect energy expenditure and physical activity patterns (Murphy, 2009; Welk et al., 2000). There are also questions of their use with older adults, because their accuracy decreases at low speed (Cyarto, et al, 2004; Le Masurier and Tudor-Locke, 2003) and with people who have gait patterns and obesity (McClung et al., 2000). Thus, pedometers might not be an ideal method for older people, although efforts have been made to improve the accuracy of pedometers working at low speed, such as equipped them with piezoelectric components. For example, the Stepwatch-3 is a pedometer with a piezoelectric component which could provide more precise data on physical activity at low speed than others (Foster et al., 2005).

ACCELEROMETERS

Accelerometers are enabled to measure physical activity objectively using motion sensors to record the amount, intensity (including approximate estimates of energy expenditure), frequency and duration of activity (Davis and Fox, 2007; Murphy, 2009). Accelerometers can assess PA on a minute-by-minute basis, over days or weeks if needed (Davis and Fox, 2007). Therefore, they have a significant role in studies that endeavor to identify the relationship between PA and the built environment. However, accelerometers are unable to capture what kind of activity older adults have performed. Therefore, with the absence of domainspecific information, we do not know the aims of physical activity in the older adult population (i.e. whether they are walking for leisure or for transportation).

However, Some researchers have also expressed concern about the accuracy of accelerometers due to the placement of monitors and the number of days worn (Murphy, 2009). In a lab-based study for older adults, Sumukadas has found that even the choice of on which hip the monitor is worn can lead to different outcomes (Sumukadas et al., 2008). It is also suggested that participants' compliance with wearing protocols could pose a difference on the final outcomes. It might be problematic with older adults as they are more likely to suffer from poor memory and cognitive impairment, failing to attach the equipment in the required position on time (Esliger, 2009; Wilcox et al., 2001). However, a large sample study of healthy European older adults aged 70 and above, has shown high levels of compliance and few administrative problems in final results, demonstrating that accelerometer appeared to be a feasible instrument for assessing different aspects of physical activity in the old population (Davis and Fox, 2007).

From all reviews above, each measurement technique comes with its own advantages and disadvantages, there is no single method for a highly accurate measurement of physical activity for older adults. To summarize, before deciding which physical activity measurements to be employed, it is necessary to very critically reflect on what information is required to answer research questions. Considering the advantages and disadvantages of both self-report and objective measures, a combination of measures may be able to provide a more precise, comprehensive and valid assessments (Atienza et al., 2011; Harris et al., 2009), this appears to be a potential way to reducing bias and increase accuracy in physical activity assessments of older adults.

2.2 MEASUREMENTS OF URBAN GREEN SPACE AND THEIR RELEVANT ENVIRONMENTAL CONTEXTS

There is a growing evidence base suggests that green space is related to people's mental and physiological health (Ward Thompson, 2011), and that green space also creates economic, social and environmental benefits (Crompton, 2001; Kaczynski et al., 2009; Orsega-Smith et al., 2004). The links between general health and green space provision derive from contacts with natural environments, social interaction and physical activity (Ward Thompson, 2011). Therefore, it is logical to assume that welldesigned green space with high accessibility and availability could improve the physical activity levels of older adults and benefit their health. And thus, should be a strategic way to boost health ageing and ageing in place. However effective policy must be based on an accurate understanding on how public green space and their surrounding areas influence physical activity of older adults. Except for PA measurements for older adults, as has described above, measuring PA-related built environment variables is another key issue in this study area.

Built environment measurements can be based on both perceived or objective influences on PA. Subjective influences focus on questions including perceived safety, noise problems, self-rated quality of life and satisfaction with the neighborhoods (Burton et al., 2011; Carlson et al., 2012). Physical activity frequencies in the nearest UGS have also been examined (Schipperijn et al., 2013), usually by using checklists and questionnaires. As regard to objective built environment influences, key variables including street connectivity, block size, land use mix and residential density (Burton et al., 2011), often using Geographic Information System (GIS) (Dyck et al., 2011; Edwards et al., 2015; Leslie et al., 2007).

Technological developments are also providing new data and analytical opportunities, such as using Google Street View to capture a range of built environment attributes objectively, thus avoiding onsite survey (Kelly et al., 2013; Rundle et al., 2011). Meanwhile, most instruments have been focused on assessing the broad urban built environment and community environment scales, including housing (Iwarsson et al., 2007; Werngren-Elgström et al., 2009), neighborhood environment (Villanueva et al., 2014) and a broader urban environment context (Purciel et al., 2009), with limited emphasis on parks (Alves et al., 2008; Kaczynski et al., 2014). Furthermore, most studies pay attention to adults, adolescents and children rather than older adults.

These are clearly identified gaps amongst research related to physical activity, built environment and older people.

Although this review has focused on key attributes of urban green space, it is also important to note that these spaces functions depend substantially on their wider contexts. Thus, a number of studies have examined the qualities, attractiveness and size of parks, as well as the influence of proximity to parks, trying to explore if these variables are related to PA. (Cohen et al., 2010; Edwards et al., 2015; Kaczynski et al., 2009; Schipperijn et al., 2013). Relevant measurements of the built environment for physical activity can be grouped into three categories: 1) perceived (self-reported) environment measures; 2) observational measures; 3) GISbased measures (Brownson et al., 2009).

2.2.1 PERCEIVED (SELF-REPORTED) ENVIRONMENT MEASURES

Questionnaires are widely used to gauge the influence of the built environment by interviewers or by self-administered methods. Brownson et al. (2009) review measurements for the perceived environment, including Perceptions of Environmental Support Questionnaire, Neighborhood Environment Walkability Scale (NEWS). NEWS is the most widely used to measure inhabitant's perceptions of the built environments (Brownson et al., 2004; Cerin et al., 2006), along with its abbreviated version ANEWS. Its reliability for youth (NEWS -Y) has been examined by Rosenberg et al. (2009), and future research will focus on a version for older adults (Cerin et al., 2006; Garin et al., 2014; Leslie et al., 2005; Saelens et al., 2003).

Meanwhile, some researchers continue to develop specific questionnaires for their own studies. for example, in the study by Schipperijn et al. (2013), used a questionnaire to rate the importance of different features in green space, finding significant associations between the preferred features and PA-related features. This suggests that instead of restricting research to physical activity-supported factors such as pitches, tracks and pavements, park users' self-rated preferences could also provide important insights for future research.

2.2.2 OBSERVATIONAL MEASURES

Unlike perceived-environment measures, researchers have developed measurements to observe the built environment using both in person and virtual tools. Table 1 illustrates observational instruments for the built environments can be used to measure different geographical scales. At the community level, there are instruments such as Neighborhood Active Living Potential (Craig et al., 2002), Physical Activity Resource Assessment (PARA) instrument (Lee et al., 2005), Senior Walking Environmental Audit Tool (SWEAT) (Cunningham et al., 2005), Neighbourhood Design Characteristics Checklist (NeDeCC) (Burton et al., 2011) et.al; at the park level, there are Bedimo-Rung Assessment Tools–Direct Observation (BRAT–DO) Instrument (Bedimo-Rung et al., 2006) , Environmental Assessment Of Public Recreation Spaces (EAPRS) tool (Saelens et al., 2006), the Public Open Space Tool (POST) (Edwards et al., 2013), System for Observing Play and Recreation in Communities (SOPARC) (McKenzie et al., 2006) et.al and at the trail level, there are Path Environment Audit Tool (PEAT) (Troped et al., 2006), Microscale Audit of Pedestrian Streetscapes (MAPS) tool (Millstein et al., 2013) et.al.

Geographical Scales	Instruments
Community level	Neighborhood Active Living Potential
	Physical Activity Resource Assessment (PARA) Instrument
	Senior Walking Environmental Audit Tool (SWEAT)
	Neighbourhood Design Characteristics Checklist (NeDeCC)
Park level	Bedimo-Rung Assessment Tools–Direct Observation (BRAT–DO) Instrument
	Environmental Assessment of Public Recreation Spaces (EAPRS) Tool
	Public Open Space Tool (POST)
	System for Observing Play and Recreation in Communities (SOPARC)
Trail level	Path Environment Audit Tool (PEAT)
	Microscale Audit of Pedestrian Streetscapes (MAPS) Tool

Table 1 - Observational instruments for the built environments

EAPRS is a very comprehensive instrument for measuring the physical environment of public parks and playgrounds, covering a wide variety of features, including paths, water areas, eating/drinking facilities, aesthetics and so on, and it shows high reliability (Saelens et al., 2006). It has been frequently used in studies to characterize the features of UGS (Edwards et al., 2015; Kane et al., 2015; Lackey and Kaczynski, 2009; Schipperijn et al., 2013). However, just as EAPRS is a very comprehensive audit tool, even a revised version has 646 items (Saelens et al., 2006), which is very time-consuming to conduct, thus an abbreviated version of EAPRS more physical activity-related and older adults-related is expected. SOPARC is another reliable and feasible instrument that focus on park usage and physical activity behaviour (Wen et al., 2007). This instrument is commonly used among park-based physical activity studies (Cohen et al., 2009; Hunter et al., 2015; Tully et al., 2013; Veitch et al., 2014).

Other instruments, such as NeDeCC, which is used to measure residential environment at an individual level, can improve our understanding on how physical environments of an individual's house (from front door to wider community) affect their wellbeing (Burton et al., 2011). The Microscale Audit of Pedestrian Streetscapes (MAPS) is a another approach to measure details of streetscapes to create a activityfriendly environment (Cain et al., 2014; Millstein et al., 2013).

Technological developments such as Google Earth and Google Street View have stimulated built environment measurements that do not require on-site survey (James et al. 2016; Bader et al. 2015; Vanwolleghem et al. 2016; Rundle et al. 2011). Remote observation approaches such as the Public Open Space Desktop Auditing Tool (POSDAT) (Edwards et al., 2013) and the Computer Assisted Neighborhood Visual Assessment System (CANVAS) (Bader et al., 2015) have advantages of lower cost, less time consuming and an ability to larger and more geographically dispersed areas (Edwards et al., 2013).

2.2.3 GIS-BASED MEASURES

GIS-Based measures here refer to measures that utilize existing spatial data such as address and census boundary identification (Brownson et al., 2009). GIS-Based measures are frequently used to evaluate physical activity-related built environment variables such as walkability, proximity to UGS (Lawrence D. Frank et al., 2005). GIS-based measures offer very important approaches to make assessments on the built environment rapidly, but there are some concerns regarding the accuracy of GIS data (James et al., 2016) or the ways of using GIS-based measures to assess walkability, such as whether using footpath networks or road center lines as a proxy (Ellis et al., 2016) etc. These are described below.

ACCURACY OF GIS DATA

Lin et al., (2010) and Hajna et al., (2013) have suggested that GIS is an effective approach to measure walkability objectively. It comes with key advantages such as assessing large areas rapidly and make comparisons within and across study areas (Ellis et al., 2016). It has several drawbacks such as being reliant on routinely available spatial data and its reliability (James et al., 2016). Although the GIS measures has been approved validity and reliability by Purciel et al. (2009), there is still evidence has shown that only 28.7% data overlapped between national data sets and observer-verified data for a park located at St. Louis, MO (James et al., 2016). Thus, it is suggested that on-site survey is expected to improve the accuracy of GIS measures, especially for small scale studies. Indeed Schipperijn et al., (2013) recommend not simply rely on municipal data, but adding observer-verified entrance data to a new GIS layer for assessing the proximity to urban green space.

MEASURING WALKABILITY

'Walkability' is defined as "the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort and offering visual interest in journeys throughout the network" (Southworth, 2005, page248). Walkability has been broadly considered as an indicator that positively correlated with higher levels of physical activity. Therefore, how best to measure walkability has great significance.

There are two key aspects for the walkability measurements, which are the use of footpath networks and road center lines respectively. Mostly, road center lines have been used to measure walkability, and indeed, in some urban morphologies, road center lines do reflect the full pedestrian network as mostly footpaths are being sidewalks along roads. This is more applicable to North America and Australia, as their urban morphologies characterized in gridiron layout (Ellis et al., 2016), and these have been the settings for most physical activity studies (Hunter et al., 2015). However, in the case of other urban forms with more segregated sidewalks, road center lines could be less effective as a proxy for pedestrian connectivity, potentially leading to distortions in walkability assessments. Chin (2008) and his colleagues have examined whether connectivity would be different when incorporating street networks or pedestrian networks. The results turned out to be quite different, connectivity for some conventional neighbourhoods improved by up to 120% when pedestrian networks were adopted. In line with this study, another study in the context of the Norther Ireland also suggests significant differences between the two walkability indices from the results of Wilcoxon signed-rank sum tests, independent of the 5- minute and 10-minute network buffer zones (Cruise et al., forthcoming). Thus, in the cases of footpaths do not paralleled to roads, pedestrian networks appear to work as a more effective proxy than road center lines alone, taking into account that the influence of nonmotorized networks such as footbridges, trails through green space (Cruise et al., forthcoming; Ellis et al., 2016).

Therefore, in studies trying to explore the relationship between physical activity and urban green space, it is more reasonable to employ a network that reflects all potential paths for older adults. What is more, the walkability index has been developed and deployed mainly in the North American and the Australian context, there is, therefore, how accurate walkability could be measured with this index in the UK context is a question that worth to figure out in the next stage (Ellis et al., 2016).

MEASURING DISTANCE TO URBAN GREEN SPACE

From existing literature, it is not difficult to find that measuring distance to urban green space has attracted great research interest from researchers (Alves et al., 2008; Bedimo-Rung, 2005; Hooper et al., 2015; Oh and Jeong, 2007; Schipperijn et al., 2010). This is probably because that in line with previous studies, it is suggested that the frequency of use of UGS has significant association with the distance to it (Nielsen and Hansen, 2007; Schipperijn et al., 2010). Although we could not say that the increase in the frequency of use of UGS is absolute with higher levels of physical activity of older adults, but we can at least claim that increasing numbers of frequency of use of UGS is likely to improve physical activity levels of older adults. Therefore, how most effectively measure the distance to UGS is a critical issue needs to be addressed.

There are three main approaches measuring the distance to UGS: measured by self-evaluated distance, Euclidian distance and trail networks. In addition, if we take UGS area size in to consideration, it could also be measured by how many hectares exist with a pre-determined distance (Schipperijn et al., 2010). It is suggested by Herzele and Wiedemann (2003) that the minimum size for a community park is one hectare, although they admit that these suggestions are come from planning guidelines instead of empirical studies. In terms of other methods to measure the distance to UGS, contrary to convention wisdom which frequently judges self-evaluated distance with significant reporting bias. Schipperijn et al., (2010) and Scott et al., (2007) have found that self-evaluated distance works as a better proxy to indicate the frequency of use of UGS. Although this method has not been tested with reliability and validity among older adults, it underlines the importance of how individual’s personal experience could make a difference to the use of UGS. In addition, using footpath network has been shown to be a more accurate method to measure UGS proximity than using Euclidian distance (C. Lee and Moudon, 2008; Oh and Jeong, 2007; Schipperijn et al., 2013).

METHODOLOGY DEVELOPMENTS AND CHALLENGES: THE COMBINATION OF GPS, ACCELEROMETER AND GIS.

The combination of GPS, accelerometer and GIS has been termed as spatial energetics by James et al. (2016), and it is defined as “the incorporation of high-spatiotemporal resolution data on location (e.g., GPS combined with GIS) and time-matched energetics (e.g., accelerometer to measure physical activity and sedentary behavior) to examine how environmental characteristics, space, and time are linked to activityrelated health behaviors” (page793). GPS data could provide time-indexed geographic coordinates, which can be used to indicate the locations participants has been; to measure the speed of movement; to understand behaviour among various locations (Jankowska et al., 2015). Using accelerometer to measure physical activity objectively are now available at low cost (Troiano et al., 2014). GIS is capable to assess large areas rapidly.

Developments in accelerometer, GPS and GIS offer us a distinct perspective of view to assess physical activity objectively with detailed and dynamic environmental contexts. With these technologies researchers are now able to put forward research questions about what kind of activities are undertaken at specific times in certain places. Spatial energetics data has largely overcome some drawbacks of previous measures, for example, reporting bias from self-report methods, lack of environmental contexts by accelerometers or pedometers. The technology has leaded to a range of methodological development, while compared with traditional measurements such as hear rate monitors, pedometers, this method has a very high potential but because it is in its early stage of development, it still paces a variety of methodological challenges, across aspects of concept, analysis and ethic (James et al., 2016).

Section two of this paper has reviewed current methodological approaches that have been used in healthy planning studies. From this review, it is clear that each instrument has a specific purpose and there is no single way to obtain comprehensive and holistic data. It is important to identify potential bias within each instrument and reduce it as much as possible before the study formally begins. In the next section, we will consider potential data sources, leading to a discussion of a research design examine how urban green space could impact the physical activity levels of older adults.

3 EXISTING DATA SOURCES

3.1 OVERVIEW OF DATA SOURCE

This research aims to measure what attributes of urban green space may support and impede physical activity of older adults, and to offer recommendations for interventions can be made to urban green space to improve the physical activity levels of older adults. An enhanced understanding of physical activity behaviour of older people in green space will benefit wellbeing in society and reduction in further health burdens. With this aim, it is significant to capture the data on physical activity patterns, physical activity levels of older adults and the usage of urban green space. Using a case study from Belfast in the UK, this research draws data from three datasets (see table2): 1) the Northern Ireland Physical Activity Survey(SAPAS); 2) System for Observing Play and Recreation in Communities (SOPARC); 3) Healthy Urban Living and Ageing in Place: Physical Activity, Built Environment and Knowledge Exchange in Brazilian Cities (HULAP). SAPAS captures the overall physical activity levels of the general population; SOPARC captures the usage of local parks and HULAP offers detailed and dynamic activity data of 300 older adults. Supported by these three robust datasets, it is possible to build a comprehensive image on the physical activity patterns and physical activity levels of older adults.

Project	Time	Sample amount	Participants	Method
SAPAS	2009/10	4653	Adults (aged 16+)	Face to face interview using CAPI
SOPARC	2010/11	Not Pre-Determined	—	Direct observation
HULAP	2016-2019	A Minimum of 300 Participants	Older adults (aged 60+)	Questionnaire; GIS, GPS and Accelerometer.

Table2 - Overview of three data sources
CAPI: Computer-assisted personal interviewing

3.1.1 THE NORTHERN IRELAND PHYSICAL ACTIVITY SURVEY(SAPAS)

SAPAS assessed the physical activity levels of adults aged 16 years and over in Northern Ireland across four life domains including home, occupational, active travel and recreation. This survey was undertaken from 2009 to 2010, a total number of 4,653 participants was selected stratified randomly and be interviewed face to face using Computer Assisted Personal Interviewing(CAPI). It is a cross-sectional survey which provides robust and comprehensive national wide data on physical activity levels among adults. (Donnelly, 2010)

3.1.2 SOPARC STUDY IN BELFAST, UK

SOPARC (System for Observing Play and Recreation in Communities) is a direct observational tool that can provide information on context of parks, physical activity patterns among park users and their gender, activity levels and estimated age.

Unlike other methods including GPAQ and IPAQ which provide detailed data on a specific respondent, SOPARC is more likely to offer us a picture of random individuals' physical activity levels in the park context at a specific time point.

The instrument was conducted by Belfast City Council at six sites in Belfast, UK including Victoria Park, Orangefield Park, Flora Street, Dixon Playing Fields, Cregagh Glen, Civic Square and Clarawood Estate.

Observations was conducted from the last week in July 2010 and last week in January 2011. Thus, the use of a good range of urban green space of the general population can be provided.

3.1.3 HEALTHY URBAN LIVING AND AGEING IN PLACE: PHYSICAL ACTIVITY, BUILT ENVIRONMENT AND KNOWLEDGE EXCHANGE IN BRAZILIAN CITIES (HULAP)[1]

HULAP is a three-year project that was launched in 2016 by a research team with multi-disciplinary background from the United Kingdom and Brazil. The project addresses a wide variety of issues regarding urban planning, health inequalities and policy makers with an aim to enhance understanding of impacts of built environment on physical activity on older adults, providing evidence to relevant institutions or stakeholders to develop policies for increasing the physical activity levels of older adults and reducing health burdens in the future hopefully.

The project uses both objective and subjective data based on a sample of 300 older adults come from Northern Ireland aged 60 years and over will wear accelerometers (Actigraph GT3X) and Global Positioning System (GPS) (Qstarz BT-Q1000XT) for seven consecutive days and completing a short survey. These three datasets are all cross-sectional data with focus on physical activity, but varied from research methods, demographic groups, environmental contexts and so on. This offers robust data on different aspects of physical activity and the usage of urban green parks.

3.2 PROPOSED RESEARCH DESIGN

3.2.1 RESEARCH DESIGN

Figure 1 shows the elements of the study and how they are related. This includes appropriate physical activity measurements for older adults and the built environment measurements will be identified through literature review, meanwhile key gaps will be identified to refine research objectives. It also involves preliminary study of SAPAS and SOPARC data. Findings from the preliminary analysis will be complementary to and validated by HULAP project. The additional research could include further qualitative methods involving older park uses, such as focus groups.

As noted above, SAPAS will provide holistic and comprehensive data on physical activity of general population and will allow some insights into the overall physical activity behaviours of older adults; SOPARC gives direct observation data on the use of six parks in Belfast, UK and older adults activity with then and in the HULAP research project, it achieves data on physical activity of 300 older adults living in Belfast, UK objectively and subjectively. However, with only three hundred of older adults in HULAP, it is not clear how many of the participants will actual do physical activity in urban green space. In sum, the three datasets are complementary to each other, and provide useful insights for determining which interventions can be made to urban green space to improve the physical activity of the old.

[1] http://www.urbantransformations.ox.ac.uk/project/healthy-urban-living-and-ageing-in-place-physicalactivity-built-environment-and-knowledge-exchange-in-brazilian-cities-hulap/

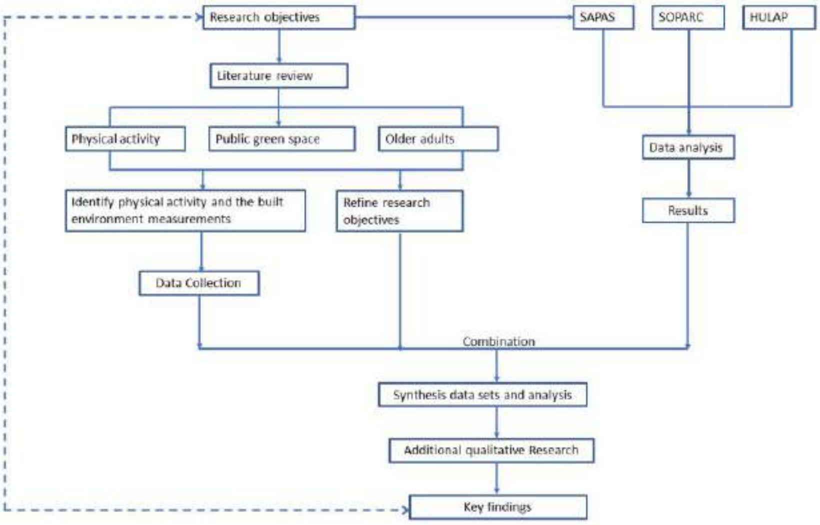

Figure 1 - Diagram of the research design

3.2.2 METHODS

Table 3 shows the three methods that will be used to collect the built environment data, including GIS-based measures; Environmental Assessment of Public Recreation Spaces (EAPRS) and Microscale Audit of Pedestrian Streetscapes (MAPS), each of these focuses on a different geographical scale. At the macro level, the GIS-based measures will be used to assess the walkability of the neighbourhoods around the six observed parks. The walkability index includes four components: residential density, intersection density and land use mix and retail floor area ratio (Frank et al., 2010). At the micro level, EAPRS is used to capture the features of urban green space. To further identify the relationship between the built environment and physical activity it is suggested that the segments between parks and participants' houses should be measured, using Microscale Audit of Pedestrian Streetscapes (MAPS). The approach will also contribute to the development of a new tool: MAPS for older adults. In terms of the physical activity measurements, approaches employed within the three data sources are listed in table 4.

Geographical scales	Macroscale	Microscale	
Object of measurement	Walkability	Street dimension	Park dimension
Quantitative measurement	GIS	Microscale Audit of Pedestrian Streetscapes (MAPS)	Environmental Assessment of Public Recreation Spaces (EAPRS)
Qualitative measurement	Focus group	Focus group	Focus group

Table 3 - Measures of the built environment

As noted above, this research has access to three robust datasets and combined with the use of these additional tools, it will be possible to address the key research questions. Additional qualitative research, using focus groups are scheduled to supplement and test the findings from literature review and data analysis.

Subjective measures	Physical activity questionnaire (From SAPAS)	Tailored physical activity questionnaire (From HULAP)	Intercept survey (From SOPARC)
Objective measures	Accelerometer combined with GPS and GIS		
Direct observation	SOPARC		

Table 4 - Measures of physical activity of older adults

4 CONCLUSION

This paper has reviewed a number of methods that can be applied to objectively and subjectively measure physical activity on older adults and the built environment including neighbourhoods, streets and green space. How best to measure physical activity levels of older adults and urban green space are two key issues in this study, improper methods may result in potential error in final results. Traditional physical activity measurements such as questionnaires, interviews and heart rate monitors, in addition with traditional built environment measurements such as perceived built environment measures and observational measures, they are appeared to provide single and static information. While spatial energetics research not only assess physical activity levels but also provide information across temporal and spatial units (James et al., 2016). It offers us novel perspectives on improving our understanding of how older adults interact with the built environment rather than single aggregate measures. Every method comes with inherent advantages and drawbacks, there remains no single way to capture comprehensive and solid data to deduce research questions. Before data collection formally begins, it is suggested to take different aspects such as research objectives, time, budget, and target population into full consideration leading to ideal research methodological approaches.

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ID 1557 | LASTING COMMUNITY WELLBEING EMBRACING HEALTH AND LIVEABILITY: COMPARISON OF LISBON AND TOKYO

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1 INTRODUCTION

Planners in many major urban areas are facing challenges affecting lasting community wellbeing (LCW), which is a key foundation for overall sustainability. LCW involves people's immediate and long-term satisfaction with decent individual and socio-ecological daily lives mainly within the scales of the neighbourhood and city-region. Community recognizes the multiple and flexible relationships of people, typified by mutual commitment and support. While the concept of community does not entail living proximity and geographical organization (e.g. on-line community, professional community, etc.), we use the concept here with emphasis on the maintenance of community in neighbourhoods, which are geographically organized areas for people living close to each other, but in many cases do not have (or have lost) community characteristics. Neighbourhoods could be considered the base level for community characteristics that are desirable for lasting wellbeing, and that build up to the city-region's level of community cooperation towards sustainability. In these terms, community is a useful perspective for considering the sustainability of daily lives.

With this perspective, comparative study of city-regions with different sizes, such as Lisbon and Tokyo, becomes possible because what matters for decent individual and socio-ecological daily lives within community (and potential or visible progress towards sustainability through them) at neighbourhoodscale is more shared than different. With recognition of what is similar, difference will be presented as a fascination (thus respectful and enjoyable), rather than something impossible to comprehend (thus fearful and hopeless).

This paper presents key features of LCW as an analytical framework and reports on an evolving comparative study of LCW centred on two city-regions – Lisbon and Tokyo – that are very different in size, history, culture and other characteristics. The viability of this comparison rests on the common features of