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Physical Activity Measurement in Elderly: The Indian Scenario

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Abstract This paper attempts to give an overview of the present condition of the sedentary elderly population in India. India's elderly has crossed the 100 million mark during 2011. This age group is found to be leading a physically inactive lifestyle not just in developed countries but developing countries as well. Physical activity was recently considered a cornerstone for combating non- communicable diseases by the UN. The elderly face many barriers for being physically active and therefore, the importance of physical activity must be highlighted to them to encourage them to involve in at least some kind of activity. Studies have been carried out in the West to establish standards for the measurement of physical activity in elderly. However, there are no specific techniques for physical activity measurement in the Indian elderly. There are a few questionnaires that are being used in the older population and their use in the Indian setting is still being investigated. The use of accelerometers is becoming fairly common in this age group and further studies are needed to evaluate these as an epidemiological tool.

Keywords: *physical activity, elderly, sedentary, accelerometry*

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1. Introduction

Census (2011) [1] reports that India's elderly population has already crossed 100 million mark during 2011. Economic, social and health aspects of this fast-growing ageing segment of our population pose a great challenge to all these sectors in India.

It is predicted that, by 2016, India will be the home to second largest number of elderly in the world and nearly half of the elderly population will be women. Elderly population analysis by the Agewell Foundation [2] shows that in upper age groups, population of older women is increasing remarkably. It is interesting to note that at the upper age groups (65, 70, 75 and 80) there are more number of elderly women (1310, 1590, 1758 and 1980 respectively) per 1000 elderly men.

Ageing is associated with a decline in many body functions; it is accompanied by a change in structure, loss of lean mass and a relative increase in fat mass over time. Earlier, these changes were considered to be intrinsically due to increasing age;however, research over the past several decades associate them to disuse which is related to ageing, low physical activity/ inactivity and degenerative diseases. These changes influence food and nutrient intakes, food preferences and the diet patterns of the elderly.

1.1. Physical Activity (PA) in Elderly

Physical activitymay be useful in improving the health and wellbeing of elderly, helps to reduce the likelihood of obesity, and delays decline in functional abilities and the onset of chronic disease. It can reduce the severity of disability that is associated with chronic diseases, improve mental health, promote socialization, prolong independent living and even reduce the risk of falls [3]. Inclusion of balance promotion as an aspect of physical activity in older people is important. Maintaining muscle strength and mass in older people will help in retaining the function and independence in them, will help them in weight management, and prevention falls and other injuries [4] thus, improving their quality of life.

PA and exercise are considered integral in lifting the potential burden of an ageing population, not only by prevention of disease, but more importantly, through the preservation of physiological reserve capacity or fitness. Regular PA allows older adults to continue to perform many tasks of daily living at older ages, required for independent function, even in disease and/or disability. With ageing, however, older adults tend to become more sedentary. The compounding effect of chronic disease along with the age-related physiological deterioration is seen on their basic activities of daily living. Increased inactivity may be due to the lack of information on the benefits and importance of physical activity and daily exercise in preserving functional independence in old age.

Physical inactivity is an independent risk factor for obesity, a range of chronic diseases and conditions that threaten the health of the nation and we know that older adults are at particular risk for leading sedentary lifestyles and being home- bound or bed-bound.

In India there is a lack of an evidence base research on the health, economic status, quality of life and well-being of the older population. The Study on global AGEing and adult health (SAGE) Wave 1 was implemented in India in 2007 as part of a multi-country study in six countries to overcome this gap. SAGE [5] is a longitudinal, household health survey; Wave 1 is the first follow-up of respondents for the SAGE survey programme in India (with the 2003 World Health Survey serving as the baseline or SAGE Wave 0). This study suggested that "older Indians are reasonably active." Among both men and women, the proportion of persons with no physical activity in the previous seven days increased with age; however, only a little more than a quarter of older respondents reported no physical activity. Inactivity was seen to rise among the oldest respondents aged 80-plus. However, the data on the physical activity was collected by means of a questionnaire, the results of which could be compared with those of the Global Physical Activity Questionnaire (GPAQ). In a recent data [6] on smoking and physical activity, it was found that alarge number of elderly in poor health were inactive.

1.2. Barriers to PA in Elderly

Persuading older adults to become physically active is challenging task. Despite having the knowledge of the health benefits of regular exercise, many older adults consider themselves too old, weak or frail to participate in such activities [7]. As exercise is not a form of a recommended medication, it's not considered important. In addition, older adults, due to multiple health problems, face more barriers to engage in physical activity and exercise. There exists a complex series of factors, apart from the ones mentioned above, which inhibit exercise participation [8].

Since PA and exercise are complex and dynamic in nature, involving an intricate series of behaviour, it becomes difficult to identify variables affecting exercise participation and adherence. Firstly, many elderly are of the view that adoption of moderate exercise is time consuming [9]. Also, that exercise is a recreational pursuit and not a necessary medical therapy. They often perceive exercise symptoms, such as sweating, laboured breathing, muscle soreness as unpleasant and negative. What adds on to the problem is the fact that many health professionals do not have the training and knowledge to prescribe exercise nor do they encourage it in the elderly.

1.3. Importance of PA in Elderly

It is very important for older people to remain physically active as this can help in decreasing the risk of many age-related conditions. A study [10] found an association between physical inactivity and depression, and that such an association was independent of pre-existing physical or psychological health status.

Thus, it becomes essential that the elderly involve themselves in some kind of physical activity to keep functional limitations and immobility at bay which may in the near future cause them to lead a dependent life affecting their overall quality of life.

It was found in a study [11] that elderly persons aged 65 years and older had lower mortality risk and fewer risks of hospitalizations if they were physically active than people who remained inactive. Even moderate physical activity has shown to help elderly to retain their ability to do recreational and household activity [12].

Aging leads to a decline is muscle mass which contributes to problems in motor movements. Approximately 12-25% of men and women 60-65 have reduced grip strength and slower gait, and the number increases to more than 40% by the age of 80 [13], which in turn has an impact on everyday life: for example, in crossing the street quickly at crossings [14].

Muscle loss is of particular concern for women at this age, who are more likely to be impaired and ultimately disabled than men. Studies have found that the lower extremity measures reflect a variety of abilities (such as balance and stride length) and are influenced by multiple physical and neurological conditions [15,16,17] whereas poor strength in their upper legs are more likely to experience decelerating gait speed and weakened ability to climb stairs [18].

Over one-third of persons over age 65 fall each year and have serious consequences like hip fracture, permanent loss of independence, institutionalization and sometimes, even death [19]. Fear of falling can result in people placing significant restriction on themselves and their physical activity [20]. This leads to a vicious cycle of reducing leg strength, stability of gait and further restrictions of activity that increase one's risk for falls.

A study found that sedentary, frail elderly who began exercise routines built their muscle mass by less than 2% and their knee extension strength increased by 8%, suggesting that little changes in muscle mass can have changes in muscle performance [21]. Knowler et al [22] found that among people who had a borderline-elevated blood sugar and who were randomly assigned to intensive lifestyle counselling increased their PA and had a significantly lower incidence of diabetes, compared to controls.

Many studies have shown that higher levels of PA reduce the risk of Alzheimer disease, vascular dementia and all-cause dementia [23,24,25]. There is also a link between physical functioning and PA, higher levels of PAcause the largest reduction in the risk of dementia [17,23,24,26,27].

1.5. Physical Activity Measurement

The ground work for PA measurement dates back to 1953 when Jerry Morris and colleagues [28] published results of their study "Bus drivers are at higher risk of cardiac events than were their more active conductor peers: London Transport Authority". Since then a number of studies are aimed at linking physical inactivity with Non Communicable Diseases (NCDs).

In 2008, majority (63%) of deaths worldwide were due to non- communicable diseases, namely diseases of the heart and vascular system, diabetes mellitus, cancers, and obstructive pulmonary disease. PA has been recently considered very important risk factor for combating non-communicable diseases by the UN [29]. WHO (2011) [30] recognizes physical inactivity as a major global risk factor for the incidence of morbidity and premature mortality. PA was defined bySchoeller and Santen (1982) [31] as "any bodily movement produced by skeletal muscles that result in caloric expenditure". PA can be placed into separate categories, such as occupational PA, leisure time PA, household chores, and transportation.

2. Methods of PA Measurement

There are many methods to determine PA in a population, even in the older adults; subjective and objective.

2.1. Subjective Methods

Self-report methods to assess PA and sedentary behaviour such as logs, questionnaires, or surveys, are often easy to administer however they can't be completely reliable as they are subject to error and recall bias [32]. The preferred method of physical activity assessment is often PAquestionnaires due to their low cost. However, there are a few instruments that have been designed specifically for older adults and it is not very clear as to which is the most accurate in this population.

Questionnaires are conveniently a popular method of PA assessment due to their ease of use and low relative cost in large population based surveys. Additional benefits include their ability to capture the duration, intensity, and type of PA as opposed to just total energy expenditure (TEE) over a period of time [33]. However, there are also some disadvantages too in the use of PA questionnaires and some of them may be the misunderstanding of questions by the participant, incorrect recall of the physical activities' duration or intensity, under/over estimation of the intensity and hence the resulting inaccurate estimation of TEE [33, 34].

There are many questionnaires that have been developed for assessment of PA in the population. The WHO has developed the Global Physical Activity Questionnaire for physical activity measurement in multiple countries [35]. It collects information on physical activity participation in three settings (or domains) as well as sedentary behaviour, comprising 16 questions. The domains are:

- Activity at work
- Travel to and from places
- Recreational activities

Questions are asked to seek data on time spent in moderate-intensity and vigorous-intensity activities within each domain. In addition to these, there are questions asked about the time expended in sedentary activity. However it is not a good indicator for measuring PA in elderly as it is domain-specific and time spent in the work domain will not be completed for most retired elderly who do not take up any voluntary work or get involved in any personal business. Since no other global questionnaire exists for the elderly population, its application in this age group is still debatable in developing countries.

International Physical Activity Questionnaire [36] (IPAQ) was developed on an international level as a tool whose results could be comparable across countries and settings and it was designed to be a self-report measure of physical activity. Several studies have been conducted to investigate its reliability and validity and it was found to be reasonable [37,38,39]. There are two versions of the questionnaire available to the investigators: long and short. The long version collects information within the domains of occupational activities, household activities (including work in the backyard), transport, and leisure time activity. For those who are retired or those who do not have any paid or unpaid work outside their home, the occupational domain can be skipped. The questionnaire also has additional questions on sedentary activity [40].

GPAQ differs from IPAQ in 2 major ways. Firstly, the work and household activities are presented as separate domains in IPAQ whereas they constitute under the work domain of GPAQ. Secondly, GPAQ focuses on physical activity in a 'typical week' whereas IPAQ emphasizes on recalling the PA done in 'the last 7 days.' In addition, GPAQ includes 'walking' in moderate intensity activity while IPAQ assesses walking separately. Both GPAQ and IPAQ give metabolic equivalent (MET) scores that can be translated to the amount of calorie expended by the subject in a week.

IPAQ has been validated in the elderly in many studies outside India [41,42,43,44]. One can argue about the validity and reliability of both the questionnaires in the older population and in developing countries like India.

Physical Activity Scale for Elderly (PASE) is a short 10-item questionnaire that aims to assess PA done in the last week by elderly above 65 years. It includes questions on leisure, household and work related activities. And answers are obtained in the form of frequency of the activities undertaken as well as the number of hours spent in that activity [45]. Responses on sitting are however, not scored. The overall scores are calculated from 'weights and frequency' values that have been established for each of the 12 types of activities. The scores can be thus obtained by multiplying amount of time spent in an activity by the item weight of that activity. So, it's a short questionnaire which is easy to administer but it measures the PA of the previous week (similar to IPAQ) and not a usual week (like GPAQ does) and may be influenced by various conditions like weather, especially in the older population as it results in a slight difference in their routine of PA. The PASE has not been used in any survey of the older population in India. Its validity and reliability in developing countries is yet to be established.

The Minnesota Leisure Time Physical Activity Questionnaire (MLTPAQ) was presented in 1978 as a tool to evaluate energy expended in leisure time activities [46]. The Minnesota Leisure Time Physical Activity Questionnaire has been modified [46] to be used in the assessment of PA in older people utilising a compendium of physical activities (which were devised in 1993 and updated [47] in 2000) and contains a comprehensive list of various physical activities along with the calculated estimates of MET codes for each activity. The questions included in this questionnaire are appropriate for the elderly who are working, semi-retired or fully retired and includes leisure activities such as walking for leisure, walking to work, using stairs even when elevators are available etc. Additional activities incorporated in the modified questionnaire were those involving household activities. Khandelwal et al [48] used a modified version of this questionnaire to determine physical inactivity in 250 hospitalised elderly patients to determine frailty. It has not been validated however in free living Indian elderly population.

The Godin Shepherd Leisure Time Physical Activity questionnaire [49] allows assessment of self-reported leisure-time physical activity and it is adapted from Godin, 1983. The leisure-time PA score is expressed in units and can be computed in two steps. First, weekly frequencies of strenuous, moderate, and mild activities are multiplied by nine, five, and three, respectively; these three latter values correspond to MET value categories of the activities listed. Then, the total weekly leisure activity score is computed in arbitrary units by summing the products of the separate components, as shown in the following formula:

$$\begin{aligned}&\textit{Weekly leisure} - \textit{time activity score}\\&= (\mathbf{9} \times \mathbf{Strenuous}) + (\mathbf{5} \times \mathbf{Moderate}) + (\mathbf{3} \times \mathbf{Mild}).\end{aligned}$$

The scores can be categorised as follows:

- 24 units and more (i.e., about 14 kcal/kg/week or more)
- 14 to 23 units (i.e., between 7 and 13.9 kcal/kg/week)
- Less than 14 units (i.e., less than 7 kcal/kg/week).

However these categories are as per the US recommendations formulated by the US Department of Health and Human Services. It needs to be validated in the Indian settings and categories need to be established as per Indian recommendations of PA for the elderly.

2.2. Objective Methods

Objective measures of PA, such as pedometers and accelerometers, have shown great potential when used in the assessment of habitual behaviour. Determining the number of days to reliably evaluate habitual PA and sedentary behaviour and reducing the participant burden as the same time poses a challenge.

Pedometers are small devices that are the most commonly used tool to count steps taken with the help of motion detection. They are usually portable and electronic or electromechanical and are placed on a person's hands or hips. They are easy to use, cost-effective in comparison to accelerometers, efficient, provide an objective measurement, and more commonly used in the elderly as it motivates them to engage in increased PA [50,51,52] since the count/ numbers of steps taken are displayed on the screen of these devices. Very few studies have actually examined its accuracy, reliability, and validity as a PA measurement tool, especially in the older population. Their accuracy is questionable, predominantly in people who walk slowly, like the frail and weak elderly [53,54,55].

Pedometers have been used in the western countries intensively in research involved in assessment of activities such as walking. In India, however, the use of pedometers has not been in trend for assessment of PA not just in elderly but in general population as well, while accelerometers are being quite popular for researchers in India. A number of studies have employed accelerometry based assessment of PA in the Indian population [56,57,58,59,60], though not in the elderly.

Accelerometers too are small devices, like pedometers, that are usually worn on a belt that can be placed on the hip and newer units are being devised that can be worn on the wrists. Accelerometers measure the frequency and amplitude [61] of acceleration of the body segment where they are located. They give us the data in the form of movement 'counts'. Accelerometers are useful in measuring sedentariness by assessing the low movement counts at specified cut points and thus, ideal for use in elderly who are less active physically.

Accelerometers record activity in epochs ranging from one to several minutes depending on the data required. In the earlier models, it was necessary to set the sampling frequency during the initialization process of the device, but in newer accelerometer models (e.g. ActiGraph GT3X+) since the data is recorded in raw form, the sampling frequency/epoch can be set at the time of processing of the data. However, it has to be done before the analysis in the software. Gathering data in shorterepochsis advantageous as it captures the highest movements even in smaller time frames and secondly it is always easier to sum up shorter epochs into longer epochs while the vice versa may not be possible. Studies have found that the period of collection of data for measurement of sedentary time is generally 7 days [62,63,64,65], but participants can be included in further analyses if there is adequate PA data for at least 3–5 days. However, a study [66] found that at least 7 days of monitoring is essential to attain estimates of time spent 'inactive'. Hart et al [67] showed that in older adults, 5 days of accelerometry data are sufficient to predict average daily sedentary time.

A major limitation of accelerometers is their inability to distinguish between postures, such as sitting and lying or standing still. Sometimes, periods of standing/sitting still may be misclassified as sedentary time or non-wear time and vice versa [68,69]. Particularly in the elderly who spend most of their time sitting, it may be difficult to differentiate between these positions unless a recall of the activities done in a specified day/time period has been recorded. New and upgraded devices are now developed and available in the markets that include an inclinometer function. It classifies posture of a person into four categories: device removed, standing, lying and sitting but it may be influenced by point of attachment [70]. In a country like ours, where the road infrastructures are not maintained by the government, travelling provides a lot of jerky movements that may get added as peaks in the graph that may be mistaken for a higher activity during that period unless it is reported otherwise by the participant. Hence another limitation may be the need to write down the activities in the form of logs to supplement the accelerometry data. This may pose a challenge in the illiterate population of our country.

Other limitations include its high initial cost that limits its usage in a large number of participants like a survey, its inability to assess water-based activities and its compliance. On the other hand, its benefits are its compact nature, its ability to record and store large amounts of data, no requirement of calibration, rechargeable battery and regular revisions in both the hardware and software. There may be many limitations to the use of this device but its validity and reliability for PA measurement cannot be overlooked. Accelerometry can be, however, used for capturing the patterns of inactivity in older adults in India in the absence of any gold standard PA measurement technique.

3. Conclusion

Physical activity in elderly is a less popular area of research, especially in a developing country like ours, where the population demographics are fast changing.

Further work needs to be done to establish measurement techniques, subjective and/or objective, of PA that are quick, accurate, appropriate and reliable for large samples of elderly population in epidemiological studies and surveys.

List of Abbreviations

PA: Physical Activity
SAGE: Study on global AGEing and adult health
GPAQ: Global Physical Activity Questionnaire
NCDs: Non- Communicable Diseases
UN: United Nations
WHO: World Health Organization
TEE: Total Energy Expenditure
IPAQ: International Physical Activity Questionnaire
PASE: Physical Activity Scale for Elderly
MLTPAQ: Minnesota Leisure Time Physical Activity Questionnaire
MET: Metabolic Equivalents
US: United States

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Competing Interests

None declared.

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