CORRELATION BETWEEN PHYSICAL ACTIVITY AND HAND LATERALITY IN ELDERLY: A CROSS-SECTIONAL STUDY

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ABSTRACT
A cross-sectional study was carried out to examine the correlation of physical activity using Godin-Shephard Leisure Time Physical Activity Questionnaire with reaction time and accuracy of hand laterality using Hand Laterality task. Around 110 individuals were assessed for the study, from which 90 participants (47 males and 43 females) who met the inclusion criteria with General Practitioner Assessment of Cognition (GPCOG) score more than 4 were selected in the study. Physical activity of participants was assessed according to Godin-Shephard Leisure-Time Physical Activity Questionnaire. The reaction time and accuracy of the hand laterality was obtained using the hand laterality task. Data was analysed using Pearson’s correlation coefficient. Mean of General Practitioner Assessment of Cognition (GPCOG) score was 6.31, physical activity score was 28.40, reaction time was 8.20 seconds and accuracy was 23.32. Results of this study demonstrated that an inverse moderate correlation was seen between physical activity score and reaction time (r value = -0.6659); whereas a moderate linear correlation exists between physical activity score and accuracy (r value = 0.5939); in elderly aged between 65-75 years. Thus, the study concludes that as physical activity increases; there is decrease in reaction time and an increase in accuracy of hand laterality in elderly population.

INTRODUCTION
Aging is a multifactorial, irreversible process associated with a significant decline in neuromuscular function (Cvecka J et al, 2015). India’s elderly population has already crossed 100 million mark during 2011 (Census of India, 2012). Aging is associated with a decline in many body functions which is considered to be intrinsically due to disuse related to aging, low physical activity/inactivity and degenerative diseases (Shaheen M et al, 2016). With aging of the population, identifying approaches to preserve cognitive function is of critical importance to maintain quality of life and independence in later years (Gallaway et al, 2017). Cognitive impairment is often accepted as a normal feature of later life; difficult to understand in early stages. Tests for detection of cognitive decline in the clinical setting usually include asking people to perform a number of tasks that assess the different cognitive domains (language, attention, memory and visuospatial or executive functioning) (Akpan A et al, 2019). Motor imagery is a cognitive task commonly used in daily life, during which, even in the absence of sensory stimulation, inner mental representations are activated and possibly determine an almost-perceptive experience (Munzert J et al, 2009). Internal action simulation or motor imagery can be defined as the ability to mentally simulate movements without actually executing them (Saimpont A et al, 2009). Motor imagery skills are evaluated by means of hand laterality in which participants have to decide whether a visual stimulus portrays a left or a right hand (Conson M et al, 2012). Determining the handedness of this visually presented stimulus is thought to involve 2 separate stages- a rapid, implicit recognition of laterality followed by a confirmatory mental rotation of the matching hand (Parsons LM, 1994). The imagined hand is a motor image, meaning that it engages sensorimotor rather than visual processes (Choisdealbha Á et al, 2011).

One of the most efficient methods to counteract age related changes in muscle mass and function is physical exercise (Paterson DH et al, 2010). Physical activity is defined as any activity involving bodily movement that produces energy expenditure greater than at rest. Physical activity can be subdivided depending on associated characteristics, for example, into household (e.g., gardening), leisure-time or recreational (e.g., walking), occupational (e.g., climbing stairs on the job), or sports-related activity (Frontera WR, 2018).

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A study conducted by Chen ST et al. (2014) has shown that healthy behaviours are associated with better self-sensed memory abilities throughout adult life, suggesting that lifestyle behaviour habits may protect brain health and potentially delay the onset of memory symptoms as people age. Thus, it is reasonable to suggest that different levels of reduced activity including a sedentary lifestyle, inactivity, and/or immobilization contribute to age-related changes and that these changes do not have to be considered inevitable consequences of the biological process of aging (Frontera WR, 2018).

There also has been an association of regular physical activity (PA) in elderly with slower cognitive decline and lower rates of dementia (Reas E et al, 2019). Impaired cognition is associated with dependency in activities of daily living, disability, and health-care costs (Lin PJ et al, 2013). Reducing the high burden of cognitive impairment and its sequelae in our rapidly aging population is a high priority that may be attainable by intervening in modifiable behaviours such as physical activity (Palta P et al, 2018). Leisure-time physical activity (LTTPA) is considered as one of the most important physical activity domains for public health intervention and research (Troiano RP et al, 2012). Compared to household, occupational, and commuting physical activities, Leisure-Time Physical Activity may provide the greatest opportunity for enjoyment and improvement in fitness- and health-related benefits (Bouchard C et al, 2007).

Physical activity has positive effects on cognition, in older persons without cognitive impairment (Asteasu MLS et al, 2017). There are various studies in the literature that were conducted to find the relationship between physical activity and mental cognition i.e. cognitive speed, visual memory, verbal memory, motor function, working memory, perception, executive functions, cognitive inhibition, visual attention, and auditory attention (Paterson DH et al, 2010). But, little is known about the influence of the physical activity on age related decline in action simulation or motor cognition. The general purpose of this experiment is to study the influence of physical activity on mental simulation on upper limb movements through a simplified version of the hand laterality task. This task was chosen because it allows an increase in the difficulty of the simulated movements simply by manipulating the orientation of the visual stimuli. Thus, the present study was aimed to find the correlation between the physical activity and hand laterality in elderly.

Experimental Section

An institutional based cross sectional study was conducted on elderly individuals. The participants were recruited in the study by convenience sampling. Individuals in the age group of 65-75 years (males as well as females), with right hand dominance and cognition score more than 4 (using General Practitioner Assessment of Cognition) were included in the study. Individuals with uncorrected visual and/or auditory impairment, having history of any vascular or neurological problem, any pathology, pain, swelling or amputation of upper extremity at the time of assessment or immobilized at the time of assessment were excluded from the study. Outcome measures assessed in the study were physical activity score (in numbers), reaction time (in seconds) and accuracy (in numbers). Permission from the head of institution and approval from the ethical committee was obtained. Elderly population between the age group of 65-75 years fulfilling the inclusion and exclusion criteria were briefed about the study in the language best understood by them and informed written consent was taken. Demographic data was documented. Around 110 participants were screened using the General Practitioner Assessment of Cognition and only those participants who scored more than 4 were included in the study. Brodaty H. et al. (2002) proved that this scale has high reliability with interrater intraclass correlation coefficients (ICC) = 0.75, test-retest ICC = 0.87 and internal consistency (Cronbach’s α) = 0.84. It is a valid tool with sensitivity of 0.85, a specificity of 0.86. Physical activity of the participant was assessed according to Godin-Shephard Leisure-Time Physical Activity Questionnaire. The reaction time and accuracy of the hand laterality was obtained using the hand laterality task. Correlation between physical activity and reaction time and also between physical activity and accuracy was measured for entire sample (n=90).

Physical activity assessment using Godin-Shephard Leisure-Time Physical Activity Questionnaire: It is a 4 item questionnaire with the first 3 questions seeking information on the number of times one engages in mild, moderate and strenuous leisure time bouts of at least 15 minutes of duration in a typical week. Scores derived from Godin-Shephard Leisure-Time Physical Activity Questionnaire include total weekly Leisure Time Physical Activity, called a Leisure Score Index in which number of bouts at each intensity level is multiplied by 3, 5 and 9 MET and summed. Leisure Score Index scores can be used for ranking individuals from lowest to highest Physical Activity Levels. Rules and terms for each activity categories that were adopted in Godin’s (2011) paper: 24 units or more: active, 14 to 23 units: moderately active and 13 units or less: insufficiently active.

Hand Laterality task: An indigenous link was created for the hand laterality task which was synced with a mobile phone application. Visual stimuli were displayed on the laptop using the link which included 16 pictorials of the right and left hand each (8 pictorials depicted hand with the palm up and 8 with the palm down configuration). These 8 pictorials in both the configuration (palm up and palm down) were of 8 different angular rotations (0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°) which appeared on the screen randomly one after the other. The answer was selected on the mobile phone application which displayed 2 options- Left and Right. They were instructed not to move their hands so as to match the position of the image displayed on the laptop. No feedback regarding accuracy and reaction time was provided. Two phases of the mental rotation task were performed. The first phase was a training phase wherein the participants were familiarized to the rotations. No time limit was present in this phase. The second phase was an experimental phase wherein the participant had to respond within 60 seconds for each hand image. All selected participants managed to respond within the given time. At the end of the hand laterality task; each participant’s total reaction time and accuracy was stored through the link in an excel sheet which was downloaded and values were documented. Test used for statistical analysis was Pearson product-moment correlation coefficient test.
RESULTS

Number of participants in age group of 65-70 years was 70 (77.87%) and in age group 71-75 years were 20 (22.22%). Therefore, total 90 participants (47 males and 43 females) were included in the study with a mean age of 68.55 years and SD of ±3.04 years. According to physical activity score, 39 participants had physical activity score range from 14-23 (moderately active) and 51 participants had physical activity score above 24 (active). Mean score of physical activity, reaction time and accuracy is given in Table 1. Correlation of physical activity with reaction time and accuracy is given in graph 1 and 2 respectively is analysed using Pearson correlation co-efficient. Both the correlations are statistically significant with p value <0.05.

Table 1 Mean and SD of study parameters

<table>
<thead>
<tr>
<th>Study parameters</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity score</td>
<td>28.40</td>
<td>8.83</td>
</tr>
<tr>
<td>Reaction time (in seconds)</td>
<td>8.20</td>
<td>2.40</td>
</tr>
<tr>
<td>Accuracy (out of 32)</td>
<td>23.32</td>
<td>5.67</td>
</tr>
</tbody>
</table>

With correlation co-efficient of -0.6659 there exists an inverse moderate correlation between Physical activity score and Reaction time which is statistically significant with p value <0.05. This indicates that with increase in Physical activity there is reduction in reaction time.

Physical activity score and accuracy are linearly correlated with r value =0.5939 (Moderate correlation) and statistically significant with p value <0.05, indicating that with increase in physical activity there is increase in accuracy.

DISCUSSION

A cross-sectional study was carried out to find correlation of physical activity with reaction time and accuracy of hand laterality in individuals aged 65-75 years. In the present study an attempt was made to correlate physical activity level with hand laterality as a measure to assess motor cognition (type of health status). Significant moderate inverse correlation was found between physical activity and reaction time using hand laterality in this study. Also a moderate linear correlation was seen between physical activity and accuracy.

The biological mechanism by which cognition is enhanced through physical exercise training remains a question, although the number of studies that have tried to identify these mechanisms has increased in the last 10 years (Bhere L et al, 2013). For the most part, the studies that support the notion that physical exercise has an impact on brain functions have focused on direct biological effects of exercise using both animal and human models. Physical activities demonstrably influence structural changes in the brain through reorganization and neurogenesis, which is likely in response to neurotrophic factors released by aerobic exercise (Urban N et al, 2014). There is evidence that newly formed neurons can integrate into a neural network and become functional. A few clinical studies have found greater hippocampal volumes among more physically active older adults (Erickson K et al, 2009, 2011).

Physical exercise is also known to induce transient and permanent changes at the structural and functional levels in the aging brain (Palta P et al, 2018). Using voxel-based morphometry (VBM), Colcombe S et al (2003) reported that a higher cardiorespiratory fitness level (VO2 max) was associated with a reduced loss of grey and white matter in the frontal, prefrontal, and temporal regions in older adults; helping them to perform executive functions like hand laterality task. In the present study, correlation of hand laterality with increased physical activity may be explained by the above mentioned study. This is also supported by Colcombe S et al (2004) that showed enhanced cardiovascular functions after aerobic training were associated with greater task-relevant activity in brain areas; recruited in an attentional control task.

Physical activity is acknowledged to be a potent non-pharmacological intervention for older adults to help prevent and manage chronic conditions and to optimize health and wellness in later life (Smart CM et al, 2017). Holstila A et al (2017) stated that light or moderate intensity leisure time physical activity was related to mental well-being whereas more intensive leisure time physical activity was related to better subjective health. Similar study was done by Panza GA et al in 2017. Evidence of the benefit of fitness on brain functions also come from functional brain imaging studies (fMRI) (Bhere L et al, 2013).

Hand laterality task is a test, used for assessing executive function of motor cognition (Saimpont A et al, 2009). Several studies are seen in literature finding association of other components of cognition with physical activity (Ravat S et al, 2013).
2019). Reas E et al (2019) concluded that even light or moderate physical activity in old age helps to preserve brain health. In a population-level analysis of a community-based cohort, Palta P et al (2018) observed that a single measure of leisure time physical activity and of physical activity sustained over a 6-year period is associated with lower cognitive decline and lower incident dementia. Findings from previous studies generally suggest that an active lifestyle imparts cognitive benefits for both men and women.

Thus, the study suggests that reaction time and accuracy is better in elderly individuals engaged in physical activity and hence, elderly should be encouraged to find time to participate in different types of physical activities in their leisure time. In the design of rehabilitation protocols hand laterality could be used as an adjunct in motor learning of elderly people. The limitation of this study was that the effect physical activity according to its severity was not correlated separately. Further studies should be carried out to find the correlation between executive function and severity of physical activity (active, moderately active and insufficiently active).

CONCLUSION

The study concludes that as physical activity increases there is improvement in reaction time and accuracy of hand laterality task in elderly aged between 65-75 years.

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