Journal of
Physiotherapy & Physical Rehabilitation

Research Article Open Access

Time of Day Influence on Mobility and Cognition in Community Dwelling Elderly Population

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Abstract

Introduction: Mobility and cognition assessments are performed in both clinical and basic research settings on a daily basis. During a 24-hrs time span our physiology and physical performance undergo radical changes as we are influenced by the circadian rhythm. The time-of-day interaction on mobility and cognition is unknown in elderly. The aim of this study was to investigate the time-of-day effect on community dwelling elderly population.

Methods: Mobility and Cognition were assessed in 60 elderly using the four outcome measures, including; Modified Mini Mental Status Examination, Berg Balance Scale, Four Square Step Test and Timed Up and Go Test. The participants underwent the same test at three different timings of the day (9:00 am, 1:00 pm and 5:00 pm) and a comparison was done among the three scores of each outcome measure.

Results: An overall significant time-of-day (between 9 am and 5 pm) effect was observed for mental status, balance, agility and gait. The variation among the scores was mostly pronounced from midday (1 pm) toward the evening (5 pm) in all four outcome measures. Specifically between 1 pm and 5 pm more significant difference between the mean values are observed as compared to that between 9:00 am and 1:00 pm.

Conclusion: This study demonstrates that time-of-day influences mobility and cognition in community dwelling elderly population. These findings have important scientific and clinical relevance, as they imply that time-of-day should be a controlled factor when assessing and also when treating cognition, balance, agility and gait.

Keywords: Stroke; Balance; Gait speed; Functional ambulation

Introduction

The process of becoming older, a process that is genetically determined and environmentally modulated is aging. According to the reports of National Institutes of Health, the World's older population continues to grow at an unpredictable rate. Today, 8.5 per cent of people worldwide (617 million) are aged 65 and over. According to a new report, "An Aging World: 2015", this percentage is projected to jump to nearly 17 per cent of the world's population by 2050 (1.6 billion)1. According to Population Census 2011 there are nearly 104 million elderly persons (aged 60 yrs or above) in India; 53 million females and 51 million males. Both the share and size of elderly population is increasing over time [1].

Age is related with decrease in efficiency of several functions, among which are balance, postural control, gait, agility and cognition, even in the absence of diseases with advancing age changes related to normal aging and those associated with diseases and their treatment can affect the systems that regulate balance, posture, mobility and cognition. A multitude of biological rhythms in the human body have been identified and some are directly affected by our environment while others have autonomic characteristics such as the heart rhythm controlled by the sinoatrial and atrioventricular node [2]. The circadian rhythm is an example of a rhythm which is primary environmentally driven. The circadian rhythm is influenced by external environmental factors such as daylight, temperature, social interactions and timing of meals [3]. During the 24 h lifespan the circadian rhythms governs many physiological functions (cognitive and metabolic state) and induce fluctuations in physiological functions that in turn affect our ability to perform various types of motor tasks [4].

Mobility is one of those which are affected in elderly population. All mobility tasks share in common, 3 essential task requirements: motion in a desired direction (progression), postural control (stability), and the ability to adapt to changing task and environmental conditions (adaptation) [5].

There are many age related changes in gait. Strength peaks in the mid 20s and declines only a little until the fifth decade, after which it falls off much faster. Gait speed remains stable until the seventh decade and slows modestly after this. Age related changes in balance of older persons result in compensatory responses that meet routine needs but may be ineffective under demanding circumstances. As a result, the mild age-related decreases in strength and balance may contribute to the increased incidence of falls in older people [5].

Walking posture also changes with the age. Older people walk with about a 5 degree greater toe out, possibly due to a loss of hip internal rotation or in a subconscious strategy to increase stability. Gait velocity falls after the age of 70 yrs. The reduction in leg muscle strength or balancing function is a major factor responsible for frequent falls by elderly people. However, fall risk is influenced by various motor factors, as evidenced by the reports that show the effect of agility training on falls [5].Agility refers to "a rapid whole body movement with change of velocity or direction to a stimulus". To adjust this definition to the needs of older adults, agility can be defined as 'the quickness of systematic motion'. Agility includes three factors: rapidity of reaction, rapidity of direction change, and velocity of muscle contraction. It

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Received: July 26, 2019; **Accepted:** December 02, 2019; **Published:** December 10, 2019

Citation: Sagar S, Walia S (2019) Time of Day Influence on Mobility and Cognition in Community Dwelling Elderly Population. Physiother Rehabil 4: 179.

also includes the cognition process and the time required for decision making. Agility training is helpful in fall reduction and improves balance confidence [6].

Balance can be defined as the ability to maintain a stable posture for maximum time with minimal body sway, or the ability to maintain the body's centre of gravity over its base of support. Impaired balance, particularly in standing posture, may limit the activities of daily living. Individuals with an increased risk of falling need to be identified at an early stage to prevent future falls, where by avoiding the potential risk of other ailments.

As people age, changes occur within the brain that lead to differences in thinking and behaviour. The time of day at which material is presented has a differential effect on immediate and delayed retention. It has been suggested that this may be mediated by a shift in the type or level of processing that subjects spontaneously engage in [7]. Ability to suppress irrelevant information and perform neuropsychological tests also varies across the day, with optimal performance typically occurring in the morning when they are most active [8].

In this study it will be concluded that how the time of day affects mobility and cognition in community dwelling elderly and how much differences will come in scales and outcome measures when elderly population will be assessed at three different timings of the day.

Materials and Methods

After the approval from Research review committee of Indian Spinal Injury Centre, New Delhi, community dwelling elderly were screened for inclusion criteria using Mini Mental State Examination and Elderly mobility scale. Then a sample of convenience of 60 community dwelling elderly subjects who met the inclusion and exclusion criteria took part in the study. They were given detailed information about the purpose and the method of the study. The patient information sheet was also handed over to the participants for further clarification and a duly signed consent form was achieved from those willing to participate in the study. All participants underwent the first assessment session, which involved the collection of demographic data by patient interviewing including age, gender and collection of their medical history. Each participant was also evaluated with the MMSE and elderly mobility scale and was recruited according to the inclusion and exclusion criteria already set. Detailed explanation was given before the conduction of task and scales. After the conduction of tasks and scales, calculation process was being done.

The subjects were invited to participate in the study. A detailed explanation of the procedure was given to the subjects. Before testing, verbal instructions and visual demonstration of how to perform the tasks was given. Pre intervention score of mini mental state examination test and elderly mobility scale obtained from every subject. When scores for these two met our inclusion criteria, subjects were called for the assessment three times a day i.e. 9 am, 1 pm and 5 pm.

For cognition, scores will be obtained from subjects on modified mini mental state examination. This includes same items as the MMSE from which it was derived, but includes four additional items, and extends the scoring range from a 30-point range for the MMSE to a 100-point range. The four new items cover long term memory (recall of date and place of birth), verbal fluency (naming animals), abstract thinking and the recall of the three words an additional time.

For dynamic balance assessment, scores on the berg balance scale was taken.

For the berg balance scale assessment, subjects were asked to sit on a chair comfortably and then all the 14 tasks of the scale were conducted under supervision. Proper support was given to the subjects whenever required in between the task. Scoring was done on the scale on the basis of number of tasks performed and how the tasks were performed by the subjects.

For agility, four step square test was conducted, once the subjects were explained about tests. A square divided into four equal halves square was marked on the floor with coloured tape and 4 cones were placed at each corner of the square. Subjects were made to stand in the starting small square and were asked to step on the count of three. Time taken by the subjects to complete the task was recorded with a stop watch.

For gait assessment, timed up and go test was explained to the subjects and then conducted with supervision. The TUGT should be performed indoors, along a long, flat, straight, enclosed corridor with a hard surface that is seldom traveled. If the weather is comfortable, the test may be performed outdoors. The walking course must be 3 meter in length. The length of the corridor should be marked every 1 m. The turnaround points should be marked with a cone (such as an orange traffic cone). A starting line, which marks the beginning and end point should be marked on the floor using brightly colored tape with a chair kept at the starting point. For the TUGT a chair was kept at the starting point of the walkway and subject was made to sit on the chair as independently as he or she can. Subject was asked to stand and go on the walkway of 3 meter on the count of three then turn around and returned back to the starting point and to be seated on the chair. Time taken by the subject from standing up to sitting back on the chair at initial point was recorded (Figure1). The whole task was done under the supervision as elderly may fall.

Each of these tasks was repeated 2 times more with the subjects in the same manner at an interval of 2 hrs. Scores from all the 3 assessments were recorded to find out the differences in their results.

Figure 1: Subject performing the Timed Up and Go Test.

Results

This chapter deals with the results of the data analysis of four variables; modified MMSE, BBS, Four Square Step Test and Timed up and go test at three different timings (9:00 am, 1:00 pm and 5:00 pm) of the day to know the differences in the readings.

A total of 60 subjects with 31 males and 29 females with a mean age of 68.49 ± 6.86 years and mean height and weight were 159.14 ± 5.14 cm and 69.34 ± 9.18 kg respectively were selected as shown in Table 1.

The analysis shows a significant difference between the readings of all four variables at three different timings of the day.

Impact of time of day on Modified MMSE (3MS)

A significant difference with F value= 354.08 (p=0.01) was found between the readings of 3MS which showed that there is a difference in the readings when measured at different timings of the day. The value of mean increases as the time progresses (92.33, 90.57, 87.90) in a day which showed the increase in the scores of 3 MS. (Table 1)

Impact of time of day on Berg Balance Scale (BBS)

A significant difference with F value= 404.19 (p=0.01) was found between the readings of BBS which showed that there is a difference in the readings when measured at different timings of the day. The value of mean increases as the time progresses (53.15, 51.90, 49.33) in a day which showed the increase in the scores of BBS (Table 2).

Impact of time of day on Four Square Step Test (FSST)

A significant difference with F value= 24.32 (p=0.01) was found between the readings of FSST which showed that there is a difference in the readings when measured at different timings of the day. The value of mean increases as the time progresses (13.40, 13.64, 13.88) in a day which showed the increase in the scores of FSST (Table 3).

Impact of time of day on Timed Up and Go Test (TUGT)

A significant difference with F value= 7.22 (p=0.01) was found between the readings of TUGT which showed that there is a difference in the readings when measured at different timings of the day. The value of mean increases as the time progresses (11.56, 11.80, 12.03) in a day which showed the increase in the scores of TUGT (Table 4).

Difference in the three mean values of each variable

Difference in the mean of each variable was calculated to find the effect of time of day on all four variables. After calculations it was found that the mean difference of first and last readings of the day of 3MS and BBS was highest and same mean difference of the FSST and of TUGT was found to be lowest. This showed that as the day progresses the readings of outcome measures of all four variables gets worse (Table 5).

Variable (3MS)	Mean	SD	P value
3MS 1	92.33	4.33	0.003*
3MS 2	90.57	4.61	0.013*
3MS 3	87.9	4.93	0.062*

Table 1: Comparison of 3MS scores of subjects at 3 different timings (9 am, 1 pm and 5 pm); (*indicates significant difference at 0.05 level).

Variable (BBS)	Mean	SD	P value
BBS 1	53.15	2.16	0.001
BBS 2	51.9	2.38	0.003
BBS 3	49.33	2.49	0.045

Table 2: Comparison of BBS scores of subjects at 3 different timings (9 am, 1 pm and 5 pm).

Variable (FSST)	Mean	SD	p value
FSST 1	13.4	2.83	0.121
FSST 2	13.64	2.86	0.277
FSST 3	13.88	2.9	0.364

Table 3: Comparison of FSST scores of subjects at 3 different timings (9 am, 1 pm and 5 pm).

Variable (TUGT)	Mean	SD	p value
TUGT 1	11.56	3.03	0.001
TUGT 2	11.795	3.08	0.001
TUGT 3	12.03	3.29	0.001

Table 4: Comparison of TUGT scores of subjects at 3 different timings (9 am, 1 pm and 5 pm).

Variable	Mean Difference		
	MD1	MD2	MD3
3MS	1.77	4.44	2.67
BBS	1.25	3.82	2.57
FSST	-0.25	-0.49	-0.25
TUGT	-0.24	-0.48	-0.25

Table 5: Comparison between mean differences of all four variables at three different timings.

Discussion

This chapter deals with the discussion of the findings of this study, its clinical implications, recommendations for future researches and limitations of the study.

This study was designed to find and compare the effect of time of day on mobility and cognition in community dwelling elderly population.

The result of our study showed that community dwelling elderly subjects deteriorates in all four variables outcome measures, namely; Modified Mini Mental Status Examination (3MS), Berg Balance Scale (BBS), Four Square Step Test (FSST) and Timed Up and Go Test (TUGT) at three different timings (9:00 am, 1:00 pm and 5:00 pm).

There was a significant decrease in the scores of Modified Mini Mental Status Examination taken at three different timings which proved that the cognitive level of elderly declines as the day progresses. In past research, Gordon Winocur and Lynn Hasher in 1999; reported that, on both tasks, performance by the old but not the young rats was affected by the time –of-day that testing was administered, at least at long delays which challenged memory for specific events. The time of day at which material is presented has a differential effect on immediate and delayed retention [8].

Scores of Berg Balance Scale also found to be decreasing significantly as the day progresses when readings were taken at three different timings of a day. A similar type of result was shown by M G Jorgensen with his colleagues in his study which demonstrated that there is an influence of time of day on PB in older adults, which is reflected by changes in selected biomechanical postural sway parameters [2]. Another study has found that time of the day had a consistent influence on dynamic postural control that suggests performance of this task may be better in the morning than in the afternoon or evening. This study was conducted on thirty healthy college-aged subjects. Static and dynamic postural control of each subject was assessed in a laboratory at 10:00, 15:00 and 20:00 on 2 consecutive days [9].

A significant increase in the time taken by subjects to perform Four Square Step Test and Timed Up and Go Test was found after conducting this research. Previous research has found stepping speed in the forward, backward and sideway directions decrease with age and is slower for fallers than for non-fallers thus increasing the time taken to perform the test [10]. A review of the biomechanical literature indicates that there are several differences in the gait characteristics of older and younger people. Older adults tend to walk slower, have a shorter step length, and a broader walking base. This results in a gait cycle with a longer stance or double support time [11-14]. It was not proved in this study or any other related study that all these affected parameters of gait gets more deteriorates with the different timings of the day. In this study we have founded this effect of time of day on gait by using TUGT.

So the overall result showed that as the day progresses both mobility and cognition gets negatively affected. The difference between the readings of all variables is more between the timing 1:00 pm and 5:00 pm as compared to that of between 9:00am and 1:00 pm. Thus, the result of this study revealed that community dwelling elderly population showed deterioration in their scores on all four variables of mobility and cognition. These changes in the outcome measures are in support with the previous studies.

A possible explanation for the time-of-day effect on these variables could relate to sleepiness and fatigue, which is affected by the circadian rhythm, the time awake and hormones. Sleepiness peaks at night (2-7 am) and in the afternoon (2-5 pm) [15], thus as subjects become sleepy their level of performance decreases. Muscle fatigue typically progress in the late afternoon since a multitude of daily activities are completed by this time. For female participants fluctuations could be partly caused by changes in oestrogen levels. A previous study found the positive effect of increased level of plasma oestrogen [16].

Clinical Implications

The data suggest that circadian rhythm affects negatively both mobility and cognition in community dwelling elderly population. These findings imply that time of day should be controlled while assessing and evaluating the mobility and cognition including balance, gait, agility and mental status. Physiotherapists can plan a treatment protocol related to these variables as per the performance level of subjects in a particular time-of-day and they choose the activities to engage the subject as per the time-of-day when activity is to be performed.

Limitations

In this study it was not possible to fully eliminate an influence of differences in the subject's physical behaviour between the various time points of testing. The participants were however strictly informed not to exercise, and not to perform heavy work or consume food or beverages, other than water 1 ½ h prior to each testing session. A small sample size is also one of the major limitations of the study. Result obtained cannot be generalized for the institutionalized elderly population as the population mostly belongs to the same community. The study population belongs to the urban sector of the society and thus, the results can not be generalized for the rural sector.

Future Research

This study was conducted on a small sample of healthy community dwelling elderly population. A further research can be undertaken by taking a large sample from different sectors of the society, which will enhance the relevance of the study. Future investigations can consider institutionalized elderly population or fallers.

Future studies should be conducted to examine the variations in these variables at later time points in the day, in order to provide a more full understanding of the variations. Scope of the further research also there in an intervention based study, to find out the effectiveness of same intervention given at different timings of the day.

Conclusion

The study demonstrates an influence of the time of day on mobility and cognition in community dwelling elderly population which is reflected by changes in the selected outcome measures. These findings have important scientific and clinical relevance, as they imply that time of should be controlled when assessing mobility and cognition and also while treating the same.

Acknowledgements

I would like to express my deep thanks to our Principal and all the faculty members of ISIC Institute of Rehabilitation Sciences. I would like to express my gratitude to the participants for their commitment to the study.

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