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Correlation between cognition and risk of falls in elderly

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Abstract
Objective: This study was to done to assess the cognitive function with the risk of fallling across participants in the elderly age group, investigating associations between the 2 aspects.
Method: 31 healthy elderly subjects in the age group of 60 to 80 were selected for the study. Their cognitive and balance profiles were assessed using the MOCA and POMA scales respectively. This data was used to identify the relationship between cognitive decline and fall risk in the elderly population.
Results: Findings revealed significant differences in MOCA and POMA scores across the age groups. It was observed that there was a positive correlation of MoCA (cognition) and POMA (balance) with statistically significant, moderately positive correlation ($r = 0.577$, $p < 0.001$) which means greater the age, higher is the risk of falling
Conclusion: Community-dwelling elderly individuals with cognitive impairments displayed an increased risk of falling.

Keywords: Fall risk, cognition, balance, ageing, Tinnetis scale, MOCA

Introduction
Falling is a common health problem and the main cause of morbidity and disability in the elderly. It is the fifth leading cause of death [1]. Age related decline in the cognitive functioning and balancing abilities are the 2 primary risk factors for falls [3].
There are a number of age-related changes that occur in different systems of the body with includes the Musculoskeletal system, Cardio-respiratory system, Sensory and Nervous system which involves decrease in the number of muscle fibres and strength, decline the cardiac output, vital capacity, loss of vision, smell, taste and poor higher mental function [2].
These physiological changes lead to an altered body balance commonly accompanied by a decline in the psychological and cognitive abilities [3].
Balance is the ability to control the centre of mass in relation to the base of support [8]. It requires an inter play between 3 systems- the afferent system, the central processing unit and the effector organ [9, 10] The afferent system collects information from the sensory receptors (visual, vestibular system and somatosensory system) and passes it on to the brain (central processing unit) which selects anticipatory postural responses which are expressed through the efferent organ (Muscle) [10].
Cognition involves memory and learning, intelligence and executive functioning [4]. The cognitive changed associated with old age are referred to as ageing associated cognitive decline (AACD) [6]. Prevalence of AACD in a population aged 65-84 was 45% [6].
Since there is a natural decline in the cognitive functioning and the balancing abilities which determine the risk of falls, it becomes imperative to study the relationship between them.
There are various studies done to correlate balance with cognition in patients with mild cognitive impairments, Alzheimer's disease and post stroke patients [11]. However, very few studies have included the elderly population.
There have been very few studies done assessing the cognition using MOCA and correlating it with the risk of falls using POMA.
The MOCA test assesses the cognitive domains of visual- spatial ability, memory, attention, language, abstract thinking and orientation.
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It has a high sensitivity and specificity of 90% and 87% respectively to detect cognitive impairment which is considerably more than MMSE [13] (Mini Mental Status Examination) which cannot assess subtle cognitive changes.
The POMA (Performance Oriented Mobility Assessment) scale is a predictor of falls and assesses both the balance and the gait which are essential components of functional mobility in comparison to the Bergs Balance Scale which measures only the balance component and has been already used in the past. The POMA scale has a good validity and reliability (Sensitivity and specificity=86%, ICC=0.74-0.93) in predicting the risk of falls [14].

Method:
This was an observational, cross-sectional study conducted in the physiotherapy department of Seth GS Medical College, Parel on a total of 31 elderly subjects in the age group of 60 to 80. It was approved by the Ethics Committee of Seth GS Medical College, Parel.
After explaining the study protocol to the volunteers, they signed the informed consent form before participating in the study.
We included elderly individuals in the age group of 60 to 80 who were able to stand and walk independently with a VAS score less than 4 and GDS score less than 9. We excluded individuals with a history of amputation and/or visual impairment or blindness, uncontrolled Diabetes Mellitus and Hypertension and those with any severe or symptomatic cardiovascular, neurological or musculoskeletal problems accounting for imbalance. The VAS and GDS were used as screening tools.

The following are the steps to conduct the procedure
Visual Analogue scale (VAS)
The visual analogue scale is a validated and reliable(α=0.87-0.96) subjective measure for acute and chronic pain [20]. Scores are recorded by making a handwritten mark on a 10 cm line that represents a continuum between 'no pain' and 'worst pain'. The subjects will place a mark on the scale that corresponds to their pain. The distance from the lower end of the scale to the mark is measured and recorded. Thus for a patient who made a mark 4cm away from the lower end scores 4 on the VAS. Grading: 0-4 indicates no pain to mild pain, 4-7 indicates moderate pain, 7-10 indicates severe pain[20]. Older individuals may suffer from osteoarthritis of the knees or any other joint pain. Thus it is important to screen subjects with moderate to severe pain as it may bias the results of the study. The investigators will administer the scale and it is freely available in the public domain.

Geriatric Depression Scale (GDS)
The GDS will be used as a screening tool. Studies have shown that depression is associated with cognitive impairments [21] Thus is becomes important to screen for depression among the subjects. The GDS has a sensitivity of 92% and specificity of 89% [18]. Grading- Total score is out of 30, normal-0-9, mild depressives-10-19, severe depressives-20-30. The investigator will administer the scale. It is freely available for use in public domain [18]. Thus permission for using the scale was not required [18].
The VAS and GDS will be used for screening the participants. Once screened, the selected subjects will be assessed on the MOCA and then the POMA scale.

MOCA scale
The MOCA test is used to assess cognition. It is a reliable and valid (α=0.867, ICC=0.912) tool to assess cognition [12]. Permission for use has been granted. Subjects will be explained the purpose of the study in the language they best understood and then they will be given the English, Hindi or Marathi version of the MOCA scale depending on the language they understand. They will be instructed on how to fill the scale. The test assesses the cognitive domains of visual-spatial ability (copy cube/draw clock), Memory (Recall after 5 mins), Attention (Serial subtraction from 100), Language, Abstract thinking, Orientation (Date, Day, Place etc.). The test performance is assessed and the total score is calculated out of 30.
Next, the same subject is then assessed on the POMA scale.

POMA scale
The POMA test is used to predict the risk of falls. POMA assesses the balance score and the gait score. The total score is calculated by adding the balance and gait score. The total score is then used to predict the risk of falls. It is a reliable and valid tool to assess the risk of falls [14]. This scale is free to use and no permission is required [19].

The results of the test are recorded by the therapist
The balance score will be calculated out of 16 by asking the subjects to maintain their balance while

- Sitting
- Standing up from the chair
- No of attempts
- Immediate standing balance
- Standing posture
- When nudged
- With eyes closed
- turning 360 degrees
- sitting down from standing

Each component is rated out of 2 points (expect sitting and eyes closed-1 point each) There are 9 components and the maximum score is 16. The gait score will be calculated out of 12. The subject will be asked to walk at their usual pace.

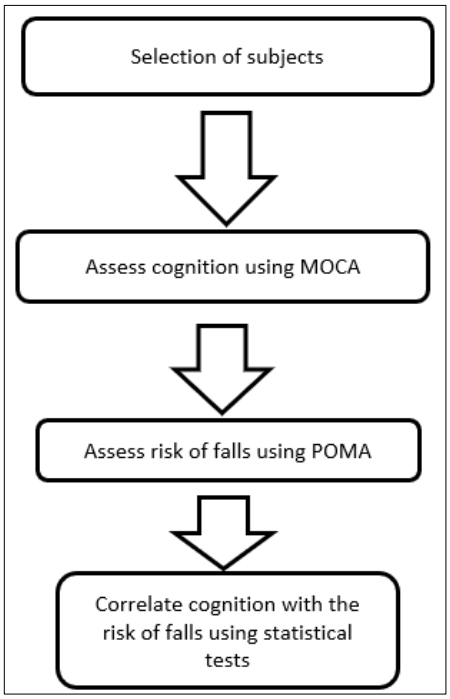
Scoring will depend on

- Initiation of gait
- Step length and height
- Step symmetry
- Step continuity
- Walking Path
- Trunk sway
- Walking stance

Each component is rated out of 1 or 2 points
There are 7 components and the maximum score is 12. The individual scores are added and total score is calculated out of 28.

Outcome Measures
MOCA (Montreal Cognitive Assessment scale)
(α=0.867, ICC=0.912) [12]
Permission has been granted. Available in English, hindi and Marathi.
The maximum score is 30

Interpretation
Normal 26-30
Impaired cognition<26



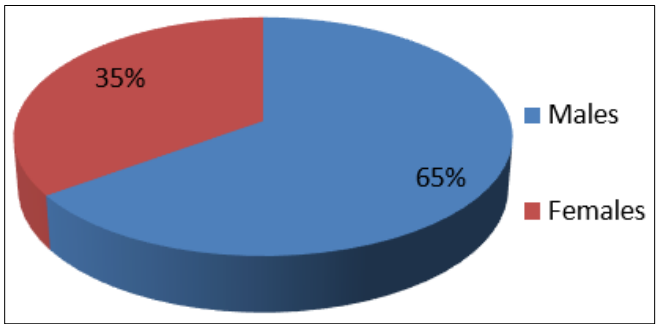
POMA (Performance Oriented Mobility Assessment)
(α=0.86, ICC=0.74-0.93) [14].
Free scale, no permission required
POMA assess balance and gait component.
Balance Component is scored out of 16.
Gait component is scored out of 12.
Total score=Balance score + Gait score i.e. out of 28

Interpretation
<19-high risk of falls
9-24-medium risk of falls
25-28-low risk of falls

Results
All the data collected was evaluated in 31 elderly subjects. Data analysis was performed using SPSS software. Data was tested for normality and Pearson's correlation test was applied as the data was normally distributed. Out of the 31 participants 11 were females and 20 were males. The mean age of the population studied was 68.11 years with a standard deviation of 3.46.
The above graph shows a positive correlation of MoCA (Cognition) and POMA (balance) with statistically significant, moderately positive correlation ($r = 0.577$, $p < 0.001$)

Discussion
Ageing involves several physical and functional changes including an altered body balance commonly accompanied by a decline in physical and cognitive abilities [24].
Control of balance, whether it is static or dynamic, is an essential requirement for daily activity. Cognitive decline of aging is characterized by loss of concentration, short term memory loss, and associated body imbalance [24]. Cognitive processing plays an important role in balance and gait and is one of the contributing factors to fall in older adults.
Maintaining balance is a complex process which involves sensory detection of postural changes, integration of sensorimotor information within the central nervous system, and execution of appropriate musculoskeletal responses [22].
Loss of balance indicates that the system has failed in some respect.
One of the possible causes for failure could be a deficit in the higher brain center's ability to allot the strategies necessary for postural stability.
The present study proves that there is a moderate linear correlation between cognition and risk of falls in elderly.
Hence it proves that as the cognition declines there is a higher tendency of falls
The study showed that there was difficulty for the elderly to recall the words. They scored low on the recall part of the MOCA test (mean 0.5).
Also, they scored low on the abstraction and attention part of the test (mean 4.74) and visuospatial and execution (mean 4). The deterioration of biological framework that underlies the ability to think and reason
This includes drop in brain volume and loss of myelin integrity, altered neurotransmitters binding and singling, giving rise to forgetfulness, poor concentration and problem-solving capability [23].
Older adults have impaired cognitive control that is associated with deterioration in prefrontal brain regions.
Thus, older adults show deficits on attention and memory tasks that require the generation and maintenance of internal strategies rather than just reliance on external cues.

Walking is an automatic process
There are motor pattern generators that control the rhythmicity of gait at the subconscious level
The planning and programming of movements is done by the prefrontal and the supplementary motor area with the basal ganglia and cerebellum [25].
These areas work in association with the cortical association areas which integrate different types of sensory and motor information [25]. With age, walking requires higher attention demands and cognitive flexibility. Furthermore, poor cognitive skills in oldage puts the individual at an increased risk of falling due to poor attention resources and poor fall strategy selection



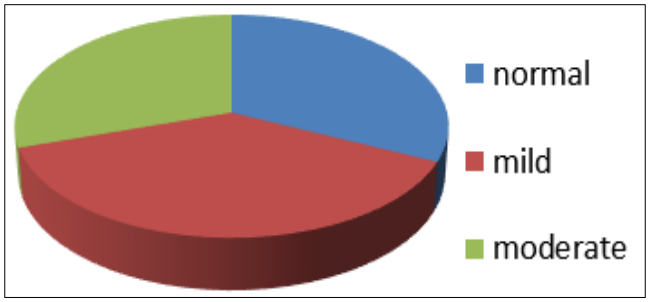
Graph 1: Shows gender-wise distribution of subjects

Table 1: Gender-wise distribution of subjects

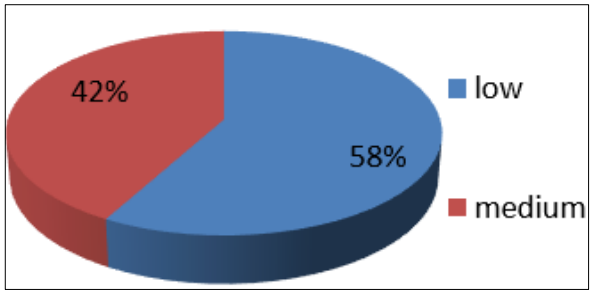
Males	65%
Females	35%

Table 2: MOCA score in Percentage

MOCA Score in Percentage	Grade
32%	Normal (26-30)
38%	Mild (18-25)
30%	Moderate (11-17)



Graph 2: MOCA score in Percentage



Graph 3: POMA score in Percentage (Risk of Fall)

Table 2: POMA score in Percentage (Risk of Fall)

POMA Score	ROF
58%	Low (25-28)
42%	Medium (19-24)

Table 3: Descriptive analysis

	MOCA	POMA
Mean	20.1	24.7
Standard Deviation	5.14	2.28

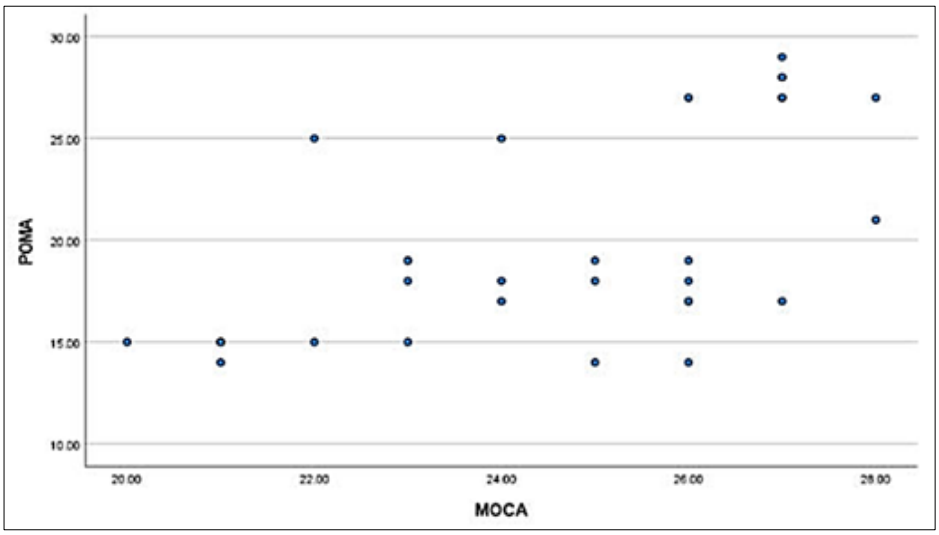


Fig 4: MoCA (Cognition) and POMA (balance)

Conclusion

The results of our study showed that balance and cognition have a positive correlation with each other. As the cognition reduces with aging the balance is also affected in such elderly.

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