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Fear of fall, History of fall and its Association with Gait Parameters in Community-dwelling Older Adults in India

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ABSTRACT

The objective of this study was to examine the influence of fear of falls (FOF) and history of falls on gait parameters in community-dwelling older adults. A total of 659 active adults above 60 years of age participated in this cross-sectional study. Demographic details, FOF, and history of falls (HOF) were recorded using a semi-structured questionnaire. Gait parameters were measured using wearable sensors during the 'timed-up and go test. Mean differences in gait parameters of those with and without fear of fall and fall history were calculated using one-way ANOVA. FOF was reported by 21.7 per cent and a history of falls was reported by 24.7 per cent of the participants. Participants with both history and fear of falls had significantly slower stride velocity, decreased cadence, increased gait cycles, time taken to stand, walk time, and turn time ($p < 0.05$) as compared to those without a history of falls and fear of fall. Therefore, FOF can be used as a marker to assess the risk of gait impairments. In low-resource settings,

FOF can be employed in routine clinical examination to identify older adults at risk of falls and developed interventions targeting FOF and gait parameters.

Keywords: Fear of falling, gait, older adults, India

Fear of falling (FOF) and history of falls (HOF) are reported as the main predictors for future falls among the older population (Makino, *et al.*, 2017; Bueno, *et al.*, 2019). FOF refers to the lack of confidence in maintaining balance during normal activities without falling (Jefferis, *et al.*, 2014). Fear of falling is associated with decreased mobility, gait and balance abnormalities, restriction in everyday functioning, anxiety, depression, and reduced quality of life (Gagnon, *et al.*, 2005; Marchetti, *et al.*, 2011; Lee, *et al.*, 2018). Older adults with FOF often adapt their gait which is described as 'cautious gait' or 'fearful gait' (such as slow gait speed, shorter steps, and longer double support time) and most of the falls occur when they walk with an adapted gait (Chamberlin, *et al.*, 2005; Giladi, *et al.*, 2005; Herman, *et al.*, 2005; Asai, *et al.*, 2017). FOF is a major health problem for older adults, as it is present not just in fallers, but also among non-fallers. However, the combination of gait alterations and fear of falling often leads to a spiral of events increasing adverse health outcomes. It is also important to note that assessment of the Spatio-temporal parameters of gait is much easier in the clinical setting, but not in a community setting. History of falls and FOF are straight forward indicators of falls and are simple to elicit information from the community.

Currently, knowledge about how various gait parameters are associated with fear of falling and whether the history of falls influences the gait parameters in older adults is inadequate in India. Increased understanding of this association will improve care and rehabilitative interventions. It is still unclear whether the relationships between FOF and gait parameters are affected by fall history. The present study aimed to compare gait parameters by the presence of FOF and fall history.

Methodology

Population and sample

The sample was drawn from the original study where data from 1152 older adults is available. For the current study, 659 records with complete gait assessment and questionnaire were selected. The sample in the original study was calculated using the population proportion sampling method. The original study, which is ongoing since 2018, aims to estimate the prevalence and risk factors for fall and fall prevention among community-dwelling older adults in Pune city. Pune is located in the Western parts of India and is very well represented by the population of India. The ethics committee of the University has approved the study.

Data collection tools and techniques

Assessment of Gait parameters

Gait was assessed using the Timed-up and go test (TUG). The participants performed the TUG test by strapping the Kinesis QTUG wearable sensor device embedded with an accelerometer and gyroscope. Participants were asked to walk over a distance of 3 meters with the sensors strapped at the shin of the legs. The start and stop points of the walking distance were marked on the floor and the participants were asked to rise from the chair without support on a count of 3. The participants walked to a distance of 3 meters, turned back, walked around to the same place, and sat back on the chair. The participants were asked to walk at their comfortable pace. Participants were given 2 trials before the actual measurement. Based on the recorded walk, various gait parameters were obtained.

Fear of fall : Fear of fall was recorded by asking a simple question to the participants. 'Do you have fear of falling? The answer was recorded as 'yes' and 'no'.

History of fall : History of falls was recorded by asking if the participants had experienced a fall in the last 12 months

Statistical analysis : A sample size of 659 adults above 60 years of age was used for this analysis. For analysis, the participants

were grouped into 4 categories; namely : (i) Fallers with Fear of fall, (ii) Nonfallers with Fear of fall, (iii) Fallers without Fear of fall, and (iv) Non-fallers without fear of fall. One-way ANOVA was used to measure the differences in gait parameters in the categories. Statistical Package for social sciences (SPSS) version 23 was used to analyze the data.

Results

The mean age of the study participants was 70.63 years (SD $\pm$ 6.6 years). Around 43 per cent (280) of the participants were male and 57 per cent (379) participants were female. The mean height and weight of the participants were 162 ± 8.85 cms and 62.15 ± 10.15 kilograms respectively. Fear of falls was reported by 21.7 per cent of the participants and a history of falls was reported by 24.7 per cent of the participants.

Several gait parameters were examined using the Kinesis QTUG wearable sensors. For the current study, parameters covered the spatial (stride velocity and stride length), dynamic transition (time taken to stand and time taken to sit), temporal (number of gait cycles, number of steps, cadence, walk time, and double support) and turning phases (pre-turn time, post-turn time and time taken to turn) in the walk test, were included.

Table 1 shows the distribution of gait parameters across participants with Fear of falls, History of falls, and both. The table shows that those with FOF and HOF reported decreased stride velocity (104.31 ± 8.40 cm/s) and stride length (118.68 ± 15.35 cm/s) and increased time taken to stand (1.61 ± 1.01 seconds) and time is taken to sit as compared to the other two groups. Participants with FOF and HOF reported a higher number of gait cycles (8.55 ± 2.13) and several steps (17.57 ± 4.21) as compared to those reporting only FOF or fall. Time is taken to turn, including pre-turn time and post-turn time were lower among participants with FOF or fall alone as compared to those with both FOF and fall. Increased walk time (10.6 ± 3.72 sec) and increased pre-turn ($5.7 + 3.18$ sec)

and post-turn time (6.65±2.86 sec) were observed in fallers with FOF as compared to fallers with no FOF. The results further showed that there was a significant increase in time taken to sit (1.7 ± 0.86 sec) among fallers with FOF as compared to non-fallers with FOF (1.43±0.81 sec). Cadence among fallers with FOF decreased (102.75 ± 13.26 steps/min) as compared to non-fallers with FOF (107.92 ± 14.13 steps/min).

Table 1
Gait parameters across participants with Fear of fall, History of fall and both

	<i>FOF (n=143)</i>	<i>HOF(n=163)</i>	<i>FOF+HOF (n=69)</i>
Gait parameters	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Average stride velocity	106.95 $\pm$ 19.13	107.35 $\pm$ 17.49	104.31 $\pm$ 18.40
Average stride length	119.04 $\pm$ 16.12	120.24 $\pm$ 14.77	118.68 $\pm$ 15.35
Time taken to stand	1.53 $\pm$ 0.87	1.46 $\pm$ 0.73	1.61 $\pm$ 1.01
Time taken to sit	1.54 $\pm$ 0.84	1.60 $\pm$ 0.80	1.70 $\pm$ 0.86
Number of gait cycles	8.44 $\pm$ 2.22	8.20 $\pm$ 1.89	8.55 $\pm$ 2.13
Number of steps	17.40 $\pm$ 4.35	16.87 $\pm$ 3.72	17.57 $\pm$ 4.21
Cadence	105.79 $\pm$ 13.97	104.66 $\pm$ 12.81	102.75 $\pm$ 13.26
Walk time	10.18 $\pm$ 3.57	9.91 $\pm$ 3.02	10.60 $\pm$ 3.72
Average double support	0.17 $\pm$ 0.06	0.16 $\pm$ 0.05	0.18 $\pm$ 0.06
Pre turn time	5.32 $\pm$ 3.09	5.12 $\pm$ 2.88	5.70 $\pm$ 3.18
Post turn time	6.21 $\pm$ 2.69	6.03 $\pm$ 2.48	6.65 $\pm$ 2.86
Time taken to turn	2.48 $\pm$ 1.64	2.45 $\pm$ 1.57	2.63 $\pm$ 1.72
Number of steps in turn	6.05 $\pm$ 22.06	6.11 $\pm$ 23.77	4.84 $\pm$ 25.98

Average stride velocity and average stride length in cm/s; time taken to stand, time taken to sit, pre-turn time, post turn time, time taken to turn, walk time and cadence are measured in seconds.

Table 2 summarizes comparisons of gait parameters across the four groups. Participants with a history of falls are coded as ‘fallers’ and those with no history of falls are coded as ‘non-fallers’. The table shows the difference between the mean values of gait parameters

across the following four groups i) Fallers with FOF ii) Fallers with no FOF iii) Non-fallers with FOF and iv) Non-fallers with no FOF. The one-way ANOVA showed significant differences in gait parameters between groups.

Table (2) shows that fallers with FOF had slower stride velocity ($p=0.02$) and increased number of gait cycles, time taken to stand, walk time, pre-turn time, post turn time ($p < 0.05$) as compared to fallers with no FOF. The results further show that there was a significant increase in the time taken to sit among fallers with FOF as compared to non-fallers with FOF ($p=0.04$). Cadence among fallers with FOF decreased (102.75 ± 13.26 steps/min) as compared to non-fallers with FOF ($p=0.03$). Only these 2 gait parameters showed a significant difference in this group. Non-fallers with FOF had a significant decrease in stride length ($p=0.04$) as compared to people without FOF and HOF. A number of gait cycles, walk time, and double support time increased significantly among fallers with FOF as compared to non-fallers with no FOF ($p < 0.05$).

Discussion

The study is of significant value as more than 100 million older adults reside in India. This study investigated the association between several gait parameters, fear of falls, and fall history. The multiple comparisons confirm that fear of falls and history of fall influence gait parameters among community-dwelling healthy older adults. Similar findings were reported by various studies conducted in the United States, Australia, and the Netherlands which showed that the presence of FOF was significantly associated with reduced gait speed, step length, and increased gait cycles (Tiedemann, *et al.*, 2005; Balash, *et al.*, 2007; Reelick, *et al.*, 2009; Kirkwood, *et al.*, 2011). Similar findings were reported in studies conducted on walking and sitting time during the 'time up and go test' in other countries (Ayoubi, *et al.*, 2014; Makino, *et al.*, 2017).

Studies have suggested that both presence of "FOF" and "fall history" together induce gait disturbances affecting the kinematic and

Table 2
Comparison of group characteristics between four groups according to their fall history and FOF

Gait parameters	Fallers with FOF	Fallers with no FOF	Non-fallers with FOF	Non-fallers with no FOF	Fallers with FOF and Fallers with no FOF	Fallers with FOF and Non-fallers with FOF	Non-fallers with FOF and non-fallers with no FOF
Average stride velocity	104.31±18.5	109.07±16.81	108.8±19.51	111.2±19.84	0.02*	0.16	0.29
Average stride length	118.61±15.35	121.12±14.43	119.3±16.72	123.46±18.79	0.39	0.83	0.04*
Time taken to stand	1.61±1.01	1.37±0.49	1.48±0.75	1.37±0.63	0.03*	0.25	0.19
Time taken to sit	1.7±0.86	1.53±0.76	1.43±0.81	1.49±0.85	0.2	0.04*	0.49
Number of gait cycles	8.55±2.13	8.00±1.71	8.36±2.28	7.67±1.64	0.06	0.53	0.00*
Number of steps	17.57±4.21	16.48±3.37	17.28±4.45	16.28±7.56	0.29	0.79	0.19
Cadence	102.75±13.26	105.74±12.48	107.92±14.13	105.75±14.45	0.19	0.03*	0.19
Walk time	10.6±3.72	9.52±2.47	9.89±3.44	9.01±2.28	0.01*	0.11	0.00*
Double support time	24.04±15.91	23.72±15.23	26.16±17.42	21.27±14.8	0.89	0.41	0.00*
Pre turn time	5.7±3.18	4.8±2.65	5.06±3.02	4.52±3.06	0.06	0.21	0.13
Post turn time	6.65±2.86	5.68±2.17	5.91±2.53	5.43±2.12	0.00*	0.05	0.07
Time taken to turn	2.63±1.72	2.35±1.47	2.37±1.58	2.03±2.75	0.46	0.51	0.23

Average stride velocity and average stride length in cm/s; time taken to stand, time taken to sit, pre-turn time, post turn time, time taken to turn, walk time are measured in seconds and cadence was measured as steps/min.
 * p-value d" 0.05.

locomotive parameters leading to slow walking speed, shorter stride length, increased double support, etc. (Li, *et al.*, 2003; Bueno, *et al.*, 2019). As a result of these changes, the person tends to have a “cautious” or “fearful” gait pattern. The changed gait parameters such as slower walking speed, decreased stride length and increased double support time increase the risk of falls among older adults (Rochat, *et al.*, 2010; Donoghue, *et al.*, 2013; Jefferis, *et al.*, 2014; Young & Williams, 2015). Thus, FOF and history of falls influence gait parameters and can be potentially used as risk factors for planning intervention. These two can be used as predictors of falls among older adults.

Unlike fall history, FOF is a potentially modifiable risk factor and older adults with a fear of falling can receive a targeted intervention to alleviate this fear and reduce its impact on health. Identification of FOF is easy and cheap as compared to other biomechanical methods. Thus, it is important to transfer this knowledge to the clinical setting and address the fear of falling among older adults to achieve the highest level of functioning. Further exploration of the underlying causes of FOF and the interaction of these factors with fall episodes is an important fall-related research issue, warranting future studies.

The strength of this study is the use of wearable sensors, which is a validated method to assess gait accurately and associate various parameters of gait with FOF and HOF. The use of a cross-sectional study design limits our interpretation of data analysis. Therefore, a prospective cohort study will be useful to observe an association between gait variability and fall events among people with and without FOF.

Policy Implications : The present findings suggest that spatial and temporal gait parameters are influenced by FOF, even in the absence of fall history. The assessment of FOF along with fall history might be helpful for a better understanding of age-related changes in gait parameters. Identifying and decreasing fear of falls and other risk factors may prevent fall incidence. These findings could be used to develop fall prevention interventions targeted toward older adults with gait disturbances.

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References

- Asai, T., Misu, S., Sawa, R., Doi, T., & Yamada, M. (2017). The association between fear of falling and smoothness of lower trunk oscillation in gait varies according to gait speed in community-dwelling older adults. *Journal of Neuroengineering and Rehabilitation*, 14(1), 5.
- Ayoubi, F., Launay, C. P., Kabeshova, A., Fantino, B., Annweiler, C., & Beauchet, O. (2014). The influence of fear of falling on gait variability: Results from a large elderly population-based cross-sectional study. *Journal of Neuroengineering and Rehabilitation*, 11(1), 128.
- Balash, Y., Hadar-Frumer, M., Herman, T., Peretz, C., Giladi, N., & Hausdorff, J. (2007). The effects of reducing fear of falling on locomotion in older adults with a higher level gait disorder. *Journal of Neural Transmission*, 114(10), 1309–1314.
- Bueno, G. A. S., Gervásio, F. M., Ribeiro, D. M., Martins, A. C., Lemos, T. V., & de Menezes, R. L. (2019). Fear of Falling Contributing to Cautious Gait Pattern in Women Exposed to a Fictional Disturbing Factor: A Non-randomized Clinical Trial. *Frontiers in Neurology*, 10, 283.
- Chamberlin, M. E., Fulwider, B. D., Sanders, S. L., & Medeiros, J. M. (2005). Does fear of falling influence spatial and temporal gait parameters in elderly persons beyond changes associated with normal aging? *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 60(9), 1163–1167.

- Donoghue, O. A., Cronin, H., Savva, G. M., O'Regan, C., & Kenny, R. A. (2013). Effects of fear of falling and activity restriction on normal and dual task walking in community dwelling older adults. *Gait & Posture*, 38(1), 120–124. <https://doi.org/10.1016/j.gaitpost.2012.10.023>
- Gagnon, N., Flint, A. J., Naglie, G., & Devins, G. M. (2005). Affective correlates of fear of falling in elderly persons. *The American Journal of Geriatric Psychiatry*, 13(1), 7–14.
- Giladi, N., Herman, T., Reider-Groswasser, I. I., Gurevich, T., & Hausdorff, J. M. (2005). Clinical characteristics of elderly patients with a cautious gait of unknown origin. *Journal of Neurology*, 252(3), 300–306.
- Herman, T., Giladi, N., Gurevich, T., & Hausdorff, J. M. (2005). Gait instability and fractal dynamics of older adults with a “cautious” gait: Why do certain older adults walk fearfully? *Gait & Posture*, 21(2), 178–185. <https://doi.org/10.1016/j.gaitpost.2004.01.014>
- Jefferis, B. J., Iliffe, S., Kendrick, D., Kerse, N., Trost, S., Lennon, L. T., Ash, S., Sartini, C., Morris, R. W., & Wannamethee, S. G. (2014a). How are falls and fear of falling associated with objectively measured physical activity in a cohort of community-dwelling older men? *BMC Geriatrics*, 14(1), 114.
- Kirkwood, R. N., de Souza Moreira, B., Vallone, M. L., Mingoti, S. A., Dias, R. C., & Sampaio, R. F. (2011). Step length appears to be a strong discriminant gait parameter for elderly females highly concerned about falls: A cross-sectional observational study. *Physiotherapy*, 97(2), 126–131.
- Lee, S., Oh, E., & Hong, G.-R. S. (2018). Comparison of factors associated with fear of falling between older adults with and without a fall history. *International Journal of Environmental Research and Public Health*, 15(5), 982.
- Li, F., Fisher, K. J., Harmer, P., McAuley, E., & Wilson, N. L. (2003). Fear of Falling in Elderly Persons: Association With

Falls, Functional Ability, and Quality of Life. *The Journals of Gerontology: Series B*, 58(5), P283–P290. <https://doi.org/10.1093/geronb/58.5.P283>

- Makino, K., Makizako, H., Doi, T., Tsutsumimoto, K., Hotta, R., Nakakubo, S., Suzuki, T., & Shimada, H. (2017). Fear of falling and gait parameters in older adults with and without fall history. *Geriatrics & Gerontology International*, 17(12), 2455–2459.
- Marchetti, G. F., Whitney, S. L., Redfern, M. S., & Furman, J. M. (2011). Factors Associated With Balance Confidence in Older Adults With Health Conditions Affecting the Balance and Vestibular System. *Archives of Physical Medicine and Rehabilitation*, 92(11), 1884–1891. <https://doi.org/10.1016/j.apmr.2011.06.015>
- Reelick, M. F., van Iersel, M. B., Kessels, R. P., & Rikkert, M. G. O. (2009). The influence of fear of falling on gait and balance in older people. *Age and Ageing*, 38(4), 435–440.
- Rochat, S., Büla, C. J., Martin, E., Seematter-Bagnoud, L., Karmaniola, A., Aminian, K., Piot-Ziegler, C., & Santos-Eggimann, B. (2010). What is the relationship between fear of falling and gait in well-functioning older persons aged 65 to 70 years? *Archives of Physical Medicine and Rehabilitation*, 91(6), 879–884.
- Tiedemann, A., Sherrington, C., & Lord, S. R. (2005). Physiological and psychological predictors of walking speed in older community-dwelling people. *Gerontology*, 51(6), 390–395.
- Young, W. R., & Williams, A. M. (2015). How fear of falling can increase fall-risk in older adults: Applying psychological theory to practical observations. *Gait & Posture*, 41(1), 7–12.

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Relationship between Muscle Strength and balance in Lower Limb among the Geriatric Population : A Narrative Review

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ABSTRACT

The purpose of this narrative review was to understand the influence of lower limb muscle strength on balance among the geriatric population. For this purpose, eleven articles published in last past five years (2013-2021) were reviewed. These studies were based on elderly persons of 65 years and above and were selected from PubMed and Google scholar using keywords and filters. Studies on unstable physical conditions, including illness, and fall risk due to other than musculoskeletal reasons were excluded. The reviewed articles apprise the influences on lower limb muscle strength with balance in the Indian geriatric population to prevent fall risks. The study concludes that there is a strong relationship between muscle strength and static and dynamic balance. It is important to understand the association between the lower limb muscle strengths in fall prevention in the Indian geriatric population.

Keywords : Muscle Strength, Balance, Lower limb, Elderly.

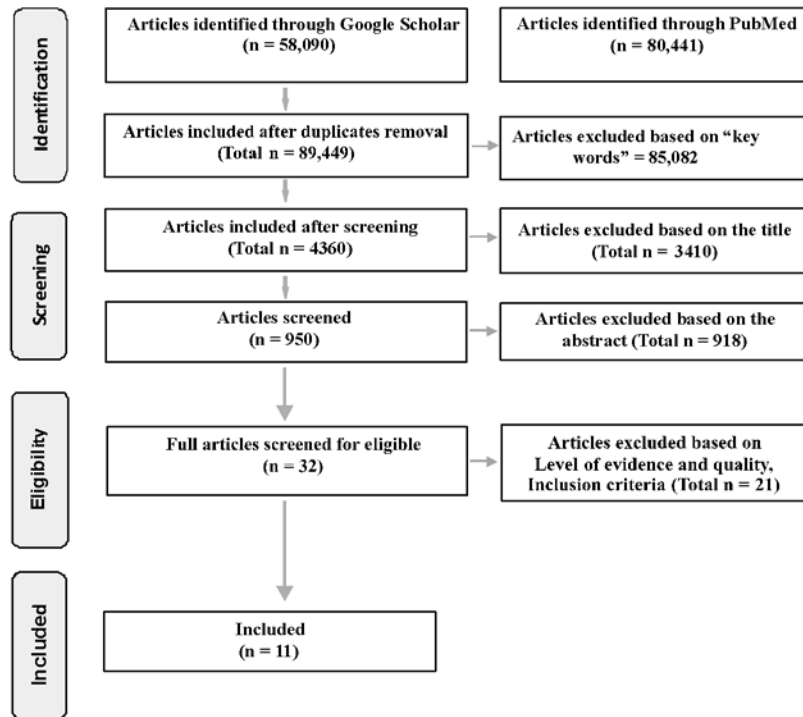
Ageing is an irreversible natural phenomenon that occurs at a molecular level that is reflected physically, functionally, and psychosocially. Although geriatric giants are common in older adults, falls are regarded as a common problem they face and a significant cause for the increase in morbidity and mortality rate among them (Pitchai, P., *et al.*, 2019). There is an optimistic association with muscle strength, gait, joint mobility, and power generation in the lower limb muscles (Gade, GV., *et al.*, 2021). Changes in the musculoskeletal system contemplate the aging process as well as the consequences of decreasing physical activities. Fall has been a very momentous and usually quotidian among the geriatric population due to various physiological, biomechanical, and etiological changes which can be sub-classified to extrinsic and intrinsic factors supporting it. It is revealed that the prevalence of falls in India is about 26 per cent - 37 per cent across different regions. The total amount of muscle fiber is decreased due to a reduction in the productive role of cells to bring out protein synthesis. There is depletion in muscle cell size, fibers, and tissue leading to total loss of muscle power, bulk, and strength. Height loss is associated with aging changes in the bones, muscles, and joints. The degenerative changes in the bones, cartilage and intervertebral disc can contribute to decreased height and postural alterations. Studies show that “the elderly population will lose almost one-half inch (about 1 cm) every 10 years after age 40, Height loss is even more rapid after age 70”. These changes can be prevented by following a healthy diet, staying physically active, and preventing and treating bone loss (Amarya, S., *et al.*, 2018). The alteration in muscle length and strength can lead to tightness and weakness of muscles, consequently leading to postural abnormalities. The postural deviation can shift the center of gravity, leading to excess energy consumption. Muscle strength and balance have a strong correlation, especially this needs consideration in the elderly due to their increased demand. There is limited literature on this among

the Indian population and the need arises to explore the evidence on the relationship between muscle strength and balance among the elderly.

A literature review was performed regarding the muscle strength of lower limbs and balance to study the influence of lower limb muscle strength on balance among the geriatric population.

Materials and Methods

A narrative review of the literature was conducted by two independent reviewers (RR, VSR) who used the PubMed, Google Scholar, and CINAHL databases. The databases were searched using “muscle strength”, “balance”, “lower limb”, “elderly”, and “geriatrics”. A systematic approach was used to evaluate the articles concerning the objective of the study. The objective of the study is to determine the influence of the strength of glutei, quadriceps femoris, and calf muscle with balance in the geriatric population by narrative review. The data was sourced to transcribe all articles related to balance and muscle strength in geriatrics that were identified using search engines PubMed and google scholar. The narrative review was carried out based on the steps stated by Fins and colleagues. Keywords were identified from the databases searched to find similar relevant articles to the topic selected. The articles obtained in the search (1, 38,531) were identified for duplicates (89,449) and the duplicates were removed. The articles were excluded based on the inclusion, and exclusion criteria (49,089). A total of 950 articles were screened for the title and abstract and 11 articles (Figure 1) were included on the basis that the quality of the articles was assessed by using SANRA and PEDRO (>60%). Articles included are within 5 years, age above 65 years, language is English, with randomized controlled trial and systematic review. Articles were excluded based on unstable physical conditions including illness, fall risk due to other than musculoskeletal reasons, and poor physical condition contraindicating physical assessment.



Findings and Discussion

The clinical studies related to the inclusion criteria were screened for eligibility, and the level of evidence ranged between 8 systematic reviews and 3 other study designs. (Table 1). The study details are summarized below (Table 2).

Table 1
Clinical studies level of evidence

<i>Journal & Year</i>	<i>Year</i>	<i>Level of Evidence</i>
Pitchai P, et al [1]	2019	IV
Gade GV, et al [2]	2021	I
Joseph A et al [3]	2019	I
Amarya, S et al [4]	2018	IV
Iwamura M et al [5]	2017	I

Sherrington C et al [6]	2020	I
Ambrens M et al [6]	2020	I
Meekes WM et al [7]	2021	I
Downs S et al [8]	2013	I
Ahmadiyahangar A et al [9]	2018	IV
Cattagni T et al [10]	2014	I

Level I -a systematic review, Level IV – Cohort study, Narrative review, descriptive study

Relationship between balance and falls among elderly

Studies from Asian and East African countries on the relationship between balance and risk of falls among the elderly have been reported in the literature. “The prevalence of falls ranges from 26 per cent to 37per cent across various regions in India”. The authors are unanimous in their recommendation that people. e”65 years have an increased risk of falls and affiliates on assessment and management strategies to prevent falls in older adults as it plays a major role in reducing mortality in this population. A multifactorial evaluation with appropriate interventions for specific imparting factors can reduce 30 to 40 percent of falls, which can be due to both intrinsic and extrinsic factors. The major contribution to the rate of falls concerning musculoskeletal problems might be due to sarcopenia, reduced muscle strength due to reduced physical activities, osteoarthritis, road traffic accidents, deformities, and many more. “The age-related changes affect 7per cent of elderly above the age of 65 years where the rate of deterioration hikes through time, men has a higher incidence than women”. The studies revealed that there is no standardized intervention to incorporate in this population to reduce the rate of fall risk. However, tailored made functional exercises with static and dynamic balance training, muscle strengthening, flexibility, and endurance training will provide more effective results and reduce the fall risk. The treatment protocol

S. No.	Journal & Year	Objective	Study design	Sample size	Result	Outcome measures	Conclusion	Limitation	Review
1.	Pitchai P, <i>et al</i> , 2019	To find the prevalence of falls, fear of falls, and its associated factors, investigate risk factors, and circumstances for falls and the level of functional independence in the elderly population.	A descriptive study	N= 2049	The study found the prevalence of falls as 24.98%. Demographic factors such as age group, education, marital status, and socioeconomic status have significance with the elderly.	Fall Efficacy Scale-International, Barthel Index, Kuppusswamy scale	The study reveals falls as a significant health problem and provides insight into the influencing risk factors for falls among older adults.	The sample was limited to one state	The risk factors for falls among older adults are outlined
2.	Gade GV, <i>et al</i> , 2021	To systematically review and critically appraise prognostic models for falls in community-dwelling older adults.	A systematic review	N= 30	The study predicts the frequency of falls to be prior falls, age, sex, measures of gait, balance, and strength, along with vision and disability	Risk of the bias assessment tool	The study suggests a prognostic prediction model complies with recent recommendations such as Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis.	The study shows a high risk of bias due to limitations in statistical methods, outcome assessment, and restrictive eligibility criteria.	The study predicts the frequency of falls to be prior falls, age, sex, measures of gait, balance, and strength, along with vision and disability

3.	Joseph A <i>et al</i> , 2019	To find the magnitude and risk factors of falls among the elderly in India.	A systematic review	N= 20 articles	The study revealed that the prevalence of falls ranges from 26% to 37% across various regions and factors, and among females.	The major contributing factors for fall injuries are aging, visual impairment, previous history of falls, depression, and gait problems.	The study revealed that the prevalence of falls ranges from 26% to 37% across various regions and factors, and among females.
4.	Amarya, S <i>et al</i> , 2018	To explore the physiological changes during the aging process	A narrative study	N= 117 articles	The study provides various factors affecting the physiological changes among the elderly which lead to various complications.	elderly face various problems and require a multi-sectoral approach involving inputs from various disciplines of health, psychology, nutrition, sociology, and social science.	The study provides various factors affecting the physiological changes among the elderly which lead to various complications.

5.	Iwamura M 2017	To examine associations of sarcopenia, frailty, and dynapenia with IADL.	A systematic review	N= 123	The study revealed that Sarcopenia had a sensitivity and specificity for dynapenia of 33% and 89%, respectively. Frailty had a sensitivity and specificity for dynapenia of 17% and 98%, respectively.	Muscle mass, grip strength, walking speed, and isometric knee extension strength, and unipedal standing	Dynapenia, more than Sarcopenia or frailty, was related to difficulties with IADL	The participants had more women than men	The study revealed that Sarcopenia had a high specificity for dynapenia. Relating the weakness and loss of power in sarcopenia.
6.	Sherrington C <i>et al</i> , 2020	To explore the evidence of physical activity in fall prevention	A systematic review	N= 25,160	The results showed that balance functional exercises will reduce the risk of falls to 24%.	Resistance training, balance training, tai chi, and GRADE	Given the strength of this evidence, effective exercise programs should now be implemented at scale.		The results showed that balance and functional exercises will reduce the risk of falls to 24%.

7.	Ambrens M <i>et al</i> , 2020	To evaluate the effect of fall prevention interventions compared with balance among the elderly in the community	A systematic review and randomized control trial	N= 24 articles	The results from this systematic review have the potential to benefit a large proportion of the population.	Balance and resistance training	The study finds interventions to have a significant impact on balance-based exercise and the prevention of falls.	The sample size is not stated	Balance as one of the components has a significant role in preventing falls among elderly
8.	Meekes WM <i>et al</i> , 2021.	To identify the most suitable risk assessment tool for the primary care setting	A systematic review	N= 85 articles	Six falls risk assessment tools were identified and all had similar reliability and specificity	TUG test, Gait Speed test, BBS, Performance Oriented Mobility Assessment, Functional Reach test	The assessment tools are reliable to be used in a clinical setting		Six fall risk assessment tools were identified and all had similar reliability and specificity including TUG, BBS, Gait speed etc.

Downs S <i>et al</i> , 2013	To check the intra and inter-rater reliability of BBS	A systematic review	N= 668	The relative Intra and inter-rater reliability were high, with a pooled estimate of 0.98 and 0.97 respectively.	Berg balance scale	The Berg Balance Scale has acceptable reliability. The relative Intra and inter-rater reliability were high, with a pooled estimate of 0.98 and 0.97 respectively.	The study comment on the absolute reliability of BBS among people with moderately poor to normal balance only.	Understand the assessment tool of BBS.
Ahmadiangar A <i>et al</i> , 2018	This study aimed to determine the association between quadriceps muscle strength (QMS) and falls in elderly subjects.	A cohort –Cross-sectional study	N= 1028	The study found the baseline QMS to be 1.28Nm/kg r below which balance is compromised.	Hand-held dynamometer	The findings indicate that older subjects with lower QMS are at greater risk of falls. These findings provide a rationale for muscle strengthening exercises in older people.	The sample considered was only from the Iran population.	QMS has an important role in maintaining balance and preventing falls among elderly

9.

10.

11.	Cattagni T <i>et al</i> , 2014	To analyze the relationship between the maximum isometric torque (MIT) of ankle muscles and CoP displacement in an upright stance	A systematic review and cross-sectional study	N= 90	The study found the strength of plantar flexors to be ≥ 30 kg below which balance is compromised among elderly.	The relationship between nMIT and nCoP implies that ankle muscle weakness contributes to increased postural instability and the risk of falling	HHD and BBS		The strength of plantar flexors is important to maintain balance and this is altered in elderly
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should also include treating for fear of falls, weight-bearing pain, and other limitations in mobility. Prime shreds of evidence indicate that long-term exercise programs for the elderly and environmental modifications in the homes of frail elderly persons will effectively reduce falls and fall-related injuries. SANRA and PEDRO scales were used to assess the quality of the articles. Most of the recent articles are at higher risk of bias due to limitations in statistical methods, outcome assessments, and restrictive eligibility criteria. The majorities of the studies manifest the magnitude of fall risk among the elderly and recommend further research to quantify and search for valid and reliable tools to assess and treat balance impairment. The studies aimed to find the most suitable assessment tool for assessing the risk of falls among the elderly and found out BBS is more reliable and valid when compared to other balance assessment tools used in clinical practice. Although Berg Balance Scale has acceptable reliability, it might not detect modest, clinically important changes in balance in individual subjects. Since the scale is easily available and widely accepted it can be considered to assess balance in the elderly population.

Muscle strength and sensitive tools to assess muscle strength in geriatrics

Studies from Asian, European, and East African countries on muscle strength assessment among geriatrics have been reported in the literature. Changes in the musculoskeletal system contemplate the aging process as well as the consequences of reducing physical activities. For musculoskeletal problems, Sarcopenia plays a major role in muscle strength reduction as there is increased loss of muscle mass. Loss of muscle strength, impaired balance, and gait disturbances form the vital signs of a fall. Since there is a loss in muscle cell size, fibers, and tissue leads to total loss of muscle power, bulk, and strength. The authors have a unanimous recommendation on reduced muscle strength and an appropriate intervention or exercises to incorporate to increase

muscle strength. The studies prove that higher physical activity and lower sedentary behavior are associated with greater skeletal muscle strength and muscle power. Age-related musculoskeletal changes are more prominent in fast-twitch muscle fibers when compared to slow-twitch muscle fibers. Most of the articles include musculoskeletal problems rather than neurological or other impairments. The studies prove that the use of a handheld dynamometer is more reliable and valid than other outcome measures to assess muscle strength. The torque values of quadriceps and calf muscle strength for fall prevention have already been proclaimed by the studies made with a population in Iran and France. The study on these postural muscles perches on the fundamental requirement to manifest the muscle torque values in the Indian population as they show profound differences in geography, physiology of muscles, and functional activities performed. As none of the studies have correlated all these major postural muscle torque values at a juncture about fall prevention it seems important to have a quantifiable value to use in clinical practice to reduce falls by strengthening the muscles among the geriatric population. Reviewed articles proclaimed that resistance training increases muscle mass and strength which reduces the rate of fall risk among older adults. This can lower morbidity, mortality, and economic expenses rate in this population. However, tailored made functional exercises with static and dynamic balance training, muscle strengthening by resistance training, flexibility, and endurance training will provide more effective results and reduce the fall risk. Since sarcopenia is a modifiable risk factor, strength and endurance training would avoid other musculoskeletal problems from arising.

Risk factors due to impaired balance in elderly

The studies revealed that developing countries comparatively have lesser attentiveness towards the geriatric population. Thus, loss of physical activity training in this population will lead to an increased

risk of falls. Commonly discussed risk factors were loss of muscle strength, fractures, intermittent claudication, peripheral artery diseases, dyspnea, and osteoarthritis. Studies from Asian, European, African, and Japanese countries have commented on the risk factors the elderly population would encounter due to loss of muscle strength and balance. To reduce the mortality rates among older adults it is significant to improve major domains of falls which include balance, mobility, and lower body strength. The authors have a unanimous recommendation that resistance training with balance training would bring down the risk factors as they are modifiable. Statistical analysis of observational studies found significant effects in favor of more active groups for neuromuscular measures such as gait speed, functionality using Timed Up and Go, Single Leg Stance, and Activities of Balance Confidence Scale, flexibility using the forward reach test, Berg balance scale, and strength using the isometric knee extension test and handheld dynamometer. A significant effect was also observed for less active groups particularly quadriceps, calf, and glutei to have an increased risk of falls. As falls are the most significant point of interest, this can be described in 3 phases. Primarily, the body's center of mass is displaced beyond its base of support, due to any following intrinsic factors such as unstable joints, muscle weakness, and unreliable postural reflexes. Secondly, failure in maintaining upright and incorporating postural strategies is mainly due to muscle weakness. Lastly, the impact on the body due to falls.

Studies from Asian and East African countries on the relationship between balance and risk of falls among the elderly have been reported in the literature. "The prevalence of falls ranges from 26 per cent to 37 per cent across various regions in India" (Joseph, *et al.*, 2019). The authors are unanimous in their recommendation that people ≥ 65 years have an increased risk of falls and affiliates on assessment and management strategies to prevent falls in older adults as it plays a major role in reducing

mortality in this population (Pitchai, P., *et al.*, 2019). A multifactorial evaluation with appropriate interventions for specific imparting factors can reduce 30 to 40 percent of falls. Falls can be due to both intrinsic and extrinsic factors. “The age-related changes affect 7 per cent of elderly above the age of 65 years where the rate of deterioration hikes through time, men have a higher incidence than women” (Joseph, *et al.*, 2019). The major contribution to the rate of falls concerning musculoskeletal problems might be due to Sarcopenia, reduced muscle strength due to reduced physical activities, osteoarthritis, road traffic accidents, deformities, and many more. Dynapenia has a close association between Sarcopenia and fragility, comparatively causing greater difficulties in carrying out instrumental activities of daily living (Iwamura, and Kanauchi, 2017)). The studies revealed that there is no standardized intervention to incorporate in this population to reduce the rate of fall risk. However, tailored made functional exercises with static and dynamic balance training, muscle strengthening, flexibility, and endurance training will provide more effective results and reduce the fall risk (Sherrington, *et al.*, 2020). The treatment protocol should also include treating for fear of falls, weight-bearing pain, and other limitations in mobility. Prime shreds of evidence indicate that long-term exercise programs for the elderly and environmental modifications in the homes of frail elderly persons will effectively reduce falls and fall-related injuries. Most of the recent articles are at higher risk of bias due to limitations in statistical methods, outcome assessments, and restrictive eligibility criteria. The majority of the studies manifest the magnitude of fall risk among the elderly and recommend further research to quantify and search for valid and reliable tools to assess and treat balance impairment (Ambrens, *et al.*, 2020). The studies aimed to find the most suitable assessment tool for assessing the risk of falls among the elderly and found out BBS is more reliable and valid when compared to

other balance assessment tools used in clinical practice. Although Berg Balance Scale has acceptable reliability, it might not detect modest, clinically important changes in balance in individual subjects (Downs, *et al.*, 2013; Meekes, *et al.* 2021). Since the scale is easily available and widely accepted it can be considered to assess balance in the elderly population. As falls are the most significant point of interest, they can be described in 3 phases. Primarily, the body's center of mass is displaced beyond its base of support, due to any following intrinsic factors such as unstable joints, muscle weakness, and unreliable postural reflexes. Secondly, failure in maintaining an upright and incorporating postural strategies is mainly due to muscle weakness. Lastly, the impact on the body due to falls. The torque values of quadriceps and calf muscle strength for fall prevention have already been proclaimed by the studies made with a population in Iran and France respectively. The torque value of quadriceps muscle strength in the prevention of falls in the elderly has already been proved to be 1.28Nm/kg in Iran's geriatric population (Ahmadihangar, *et al.*, 2018). While the torque value of calf muscle in the prevention of falls is proved to be ≈ 30 Nm/kg in France's geriatric population (Cattagni, *et al.*, 2014). The study on these postural muscles perches on the fundamental requirement to manifest the muscle torque values in the Indian population. They show profound differences in geography, physiology of muscles, and functional activities performed. A compelling point that manifests the need for study is, that none of the studies have co-related all these major postural muscle strength values at a juncture about fall prevention. As age advances, muscle mass and strength reduction result in decreased mechanical skeletal muscle properties. There is stated relevance on the postural abnormalities due to aging and muscle strength plays an important role to maintain balance. Thus, planned resistance and balance training will play a significant role in the reduction of risk factors due to aging.

Conclusion

There is a strong relationship between muscle strength and static and dynamic balance. It is important to understand the association between the lower limb muscle strengths in fall prevention in the Indian geriatric population.

References

- Ahmadihangar, A., Javadian, Y., Babaei, M., Heidari, B., Hosseini, S., and Aminzadeh, M.(2018): The role of quadriceps muscle strength in the development of falls in elderly people, a cross-sectional study. *Chiropr Man Therap* 26(1).
- Amarya S, Singh K, and Sabharwal M.(2018): Ageing Process and Physiological Changes. *Gerontology* [Internet]. 2018 4.
- Joseph, A., Kumar, D., and Bagavandas, M.,(2019): A Review of Epidemiology of Fall among Elderly in India. *Indian J Community Med* [Internet]. 44(2):166–8.
- Ambrens, M., Tiedemann, A., Delbaere, K., Alley, S., and Vandelanotte, C.(2020): The effect of eHealth-based falls prevention programmes on balance in people aged 65 years and over living in the community: protocol for a systematicreview of randomised controlled trials. *BMJ Open* 10(1).
- Cattagni, T., Scaglioni, G., Laroche, D., Van Hoecke, J., Gremeaux, V., Martin, A., (2014): Ankle muscle strength discriminates fallers from non-fallers. *Front Aging Neurosci* 6:336.
- Downs, S., Marquez, J., and Chiarelli, P.,(2013): The Berg Balance Scale has high intra- and inter-rater reliability but absolute reliability varies across the scale: a systematic review. *J Physiother* 59(2):93–9.
- Gade, GV., Jørgensen, MG., Ryg, J., Riis, J., Thomsen, K., Masud, T., and Andersen, Stig.(2021): Predicting falls in community-dwelling older adults: a systematic review of prognostic models. *BMJ Open* [Internet]. 2021 May 4 [cited 2022 May 13];11(5).
- Iwamura, M., and Kanauchi, M. A.,(2017): A cross-sectional study of the association between dynapenia and higher-level functional

capacity in daily living in community-dwelling older adults in Japan. *BMC Geriatr* [17(1):1–6.

Meekes, WMA., Korevaar, JC., Leemrijse, CJ., and Van De Goor, IAM.,(2021): Practical and validated tool to assess falls risk in the primary care setting: a systematic review. *BMJ Open*, 11(9).

Pitchai, P., Dedhia, HB., Bhandari, N., Krishnan, D., D'Souza, NRJ., and Bellara, JM.(2019): Prevalence, risk factors, circumstances for falls and level of functional independence among the geriatric population - A descriptive study. *Indian J Public Health*, 63(1):21–6.

Sherrington, C, Fairhall, N., Kwok, W., Wallbank, G., Tiedemann, A., Michaleff, ZA.,Christopher, A C M Ng., and Adrian, Bauman . (2020): Evidence on physical activity and falls prevention for people aged 65+ years: systematic review to inform the WHO guidelines on physical activity and sedentary behaviour. *Int J Behav Nutr Phys Act*, 17(1).

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Systematic Review on Declining Executive Functions in Older Adults*

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ABSTRACT

The objective of the present study was to systematically review the latest research articles on executive functions of the elderly that have been published over the last 15 years to understand if there is any pattern of decline in Executive functions and their components. The review used data sources from Google Scholar, MEDLINE, Web of Science, APA PsycNET with keywords like declining executive functions, inhibitory control, cognitive flexibility, working memory, and their synonyms in normal elderly. Results: 159 studies were identified in which 33 studies met the inclusion criteria. Considering above said period and mentioned keywords, only two studies examined the pattern of declining executive functions (working memory and inhibition) which reported diverse findings. Studies examining the impact of interventions on declining executive functions were found which indicated the positive impact of physical tasks, exercises, and activities on the decline of executive functions. The health-related mediating variables like pain; obesity; deterioration of cardiovascular fitness; and Age-related hearing loss are all found to be associated with the

decline of executive functions in older adults. Based on this study it may be concluded that there is a literature gap in understanding the pattern of decline, therefore, further studies analysing the pattern of decline in executive functions of older adults are recommended.

Keywords: Executive functions, Inhibitory control, Working memory, Cognitive flexibility, Older Adults

Cognition is known to change throughout the life span, though the changes are selective. Cognitive ability loss is considered a consequence of ageing process. Though there is a structural and cognitive process of natural aging, it is not explained in the literature. Aging is commonly related to cognitive decline. Several abilities such as attention, Memory, and Executive Functions (EF) tend to decline. According to Miyake, *et al.*, (2000) Executive function is a set of general purpose control mechanisms that modulate the operation of various cognitive sub-processes and thereby regulate the dynamics of human cognition.

In recent years there has been considerable interest in studying Executive Functions within neuropsychology and in certain areas of cognitive psychology because each Executive function involves a composite network of brain locations and cognitive processes. Since aging is unlikely to affect each of these activities, in the same manner, distinct types of executive functions must be studied separately (Anderson, *et al.*, 2010).

There is general agreement that there are three core Executive Functions (e.g., Miyake, *et al.*, 2000; Lehto, *et al.*, 2003): inhibition and interference control, working memory, and cognitive flexibility. The higher-order Executive Functions such as reasoning, problem-solving, and planning are developed from these three core executive functions (Collins and Koechlin 2012, Lunt, *et al.*, 2012).

Inhibitory control (IC)

Inhibitory control (one of the fundamental Executive Functions) refers to the ability to manage one's attention, actions, ideas, and/or

emotions to overcome a strong internal predisposition or external enticement and perform what is more suitable or essential. Cognitive inhibition is attracting a lot of attention in the developmental literature, especially at both ends of the life span, as a probable substrate of developmental change in cognition (Hasher, and Zacks, 1988; Diamond, 1990; Brainerd, and Reyna, 1993; Dempster, 1993; Bjorklund, and Harnishfeger, 1995).

Cognitive flexibility (CF) or Task Shifting

Task shifting, also known as “attention switching” or “task switching,” involves shifting attention and cognitive control between multiple relevant tasks or subtasks, mental sets, or operations meanwhile avoiding negative priming or proactive interference induced by the past performance of a various operation on the same kind of stimuli (Miyake, *et al.*, 2000; Monsell, 2003). The ability to shift back and forth between numerous tasks, operations, or conceptual sets is represented by the Shifting function (Miyake, *et al.*, 2004).

Working Memory (WM)

Working memory is another core Executive Function, which involves holding information in mind and mentally working with it (or said differently, working with information no longer perceptually present; Baddeley, and Hitch 1994, Smith, and Jonides 1999). The two types of Working Memory are distinguished by content—verbal Working Memory and nonverbal (visual-spatial) Working Memory. Working Memory is essential for making sense of everything that happens throughout time because it constantly needs to remember what happened previously and link it to what may happen ahead.

Investigations on age-related changes in Executive Functions have revealed a mixed bag of data, which are sometimes contradictory. While some authors believe that Executive Functions decline with age (West, 1996; Mejia, *et al.*, 1998; Keys, and White, 2000; De Luca, *et al.*, 2003; Fisk, and Sharp, 2004; Plumet, *et al.*, 2005), others believe that cognitive skills deteriorate more broadly with age (Salthouse, 1996). A better understanding of the effects of

age on Executive Functions and the pattern of decline is needed. With this objective, the current article aimed to systematically review the latest empirical studies on the Executive Functions of the elderly that have been published in the last 15 years. It also aims to understand if at all there is any pattern of decline in Executive functions and their components.

Method

A systematic review has been conducted on assessing the decline of Executive Functions in older adults. The study has inclusion criteria: 1. Studies published in the last 15 years from 2005 were included; 2. Studies assessing Executive Functions specifically in older adults rather than comparing with young age group were included; 3. Studies assessing only normal adults were included. The review used data sources from Google Scholar, MEDLINE, Web of Science, and APA PsycNET with keywords like declining executive functions, inhibitory control, cognitive flexibility, working memory, and their synonyms in normal elderly.

A total of 159 studies (Fig-1) were found, of which 33 of them met the inclusion criteria. 11 studies looked at either all three components of executive functions or any two of them. Two studies focus solely on Inhibitory Control, two studies focus solely on Working Memory, nine studies focus solely on Cognitive Flexibility, and eight studies focus on Executive Functions as a single factor.

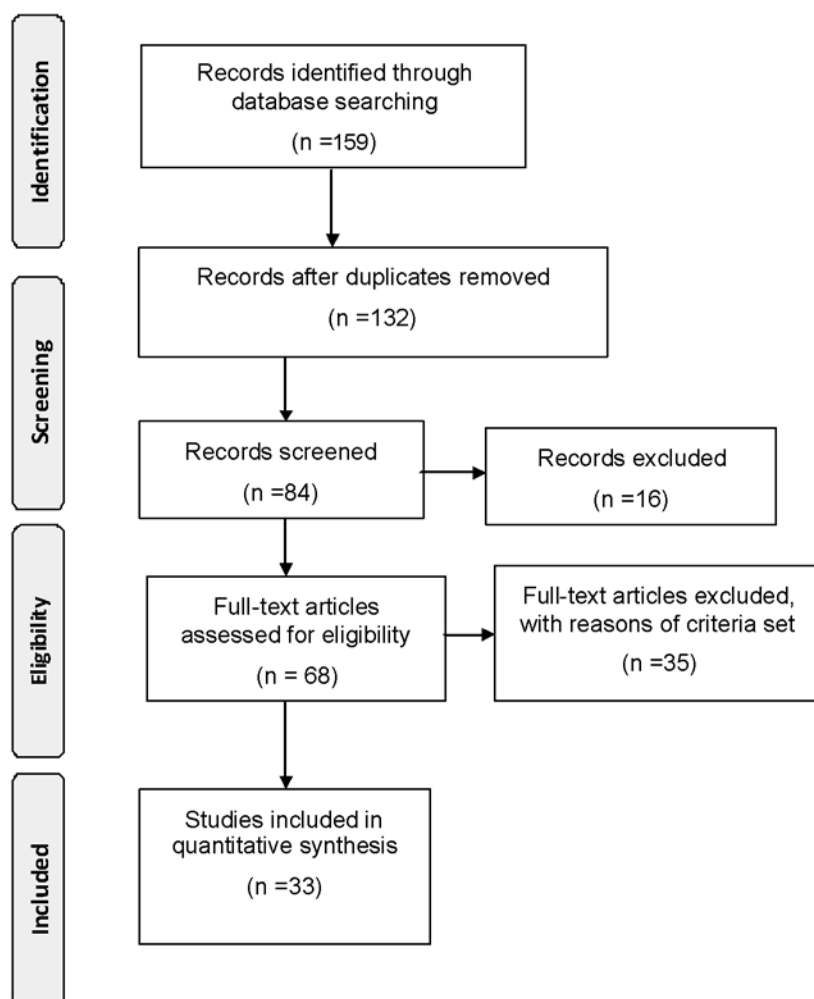
Results

Cognitive flexibility

The current study aimed to review recent empirical studies on Cognitive Flexibility (CF) as an executive function in the elderly. A total of 16 studies met the inclusion criteria, considering the period and the keywords used to search articles (Table no. 1).

These studies assessed cognitive flexibility with factors such as neural substrates, cognitive skills, and several health-related variables in the elderly. Only one study was found that examined the organisation of Executive functions in the elderly in which cognitive

flexibility was one of the components that has been studied (Hull, *et al.*, 2008). It investigated whether a single factor solution is insufficient to explain executive function performance. The organisation of Executive Functions was studied in the elderly sample using confirmatory factor analysis (CFA) and structural equation modeling (SEM), which revealed a robust emergence of shifting factors but no evidence for verbal and nonverbal factors was found.



The relation of cognitive flexibility with neural substrates in the elderly was studied by Hirsiger, *et al.*, (2017), and found the microstructural characteristics predicting task-switching performance to a certain extent than the size of frontal lobe White Matter Hyperintensity, altogether task switching was found to be associated with microstructural properties of the white matter of both frontal and parietal lobe in older adults.

Apart from neural substrates, health-related variables such as severe pain were found to be associated with increased impairment in cognitive flexibility in a smaller sample of elderly patients. (Karp, *et al.*, 2006). Similarly, obesity was found significantly associated with lower performance in cognitive flexibility, verbal ability, and processing speed in a large sample of the elderly (Ihle, *et al.*, 2016). Also, cardiorespiratory fitness was positively associated with the task switching paradigm (Verstynen, *et al.*, 2012), but due to the cross-sectional design of these studies, understanding causal inferences was not possible therefore; it was difficult to disentangle the directionality of the observed associations. Another factor, age-related hearing loss which is considered common in old age found to negatively impact cognitive flexibility in a study by Shende, *et al.*, (2021) where peripheral hearing and central hearing were associated with cognitive flexibility. Also, poorer sentence recognition in background noise was found related to alterations in cognitive flexibility suggesting decreased hearing ability is related to slowing the process of cognitive flexibility. On the other hand, health-related quality of life in older women was found to be associated with cognitive flexibility (Davis, *et al.*, 2010).

There were four studies found that involved cognitive interventions to examine cognitive flexibility in older adults. Johnco, *et al.*, (2013) tried to study the impact of cognitive flexibility on learning cognitive restructuring skills and found that cognitive flexibility positively impacts the learning of cognitive restructuring skills, but unexpectedly the set-shifting measured by Trail Making Test-B was

found unrelated to cognitive restructuring skill acquisition. This might be due to the experimental procedure adopted in the study where the participants learned the cognitive restructuring skills within a single-day session. correspondingly, two other studies examined the impact of cognitive training on cognitive flexibility where one implemented cognitive training and another implemented multifactor cognitive training (Lopes, and Argimon 2016; Chambon, and Alescio-Lautier 2019) respectively and they both found a positive impact and improvements in cognitive flexibility in older adults due to the training.

Inhibitory control

12 studies (Table no.2) were found that assessed inhibitory control and were reviewed with various factors among which only one study assessed the decline of inhibitory control in the elderly by comparing two groups: young old and oldest old, it used a quasi-experimental control design with post-test only. Participants were selected through the non-randomized convenience sampling technique and the results indicated that the groups did not differ in inhibitory control rather they differed in decision making, indicating no difference in the decline of inhibitory control in young elderly and oldest elderly (Bakos, *et al.*, 2008).

Meanwhile, Hull, *et al.*, (2008) studied the organization of executive functions in the elderly by using three inhibitory control tasks but surprisingly confirmatory factor analysis did not identify any inhibitory control factors emerging. This result was reasoned with two possibilities, first as the lack of cohesiveness among the Inhibition measures and second as the Inhibition measures involved prepotent response inhibition, and none required resistance to proactive interference. Contrary to that Wilkinson and Yang (2016) assessed inhibitory control with nine tasks and found improved inhibitory control with practice-induced plasticity; however, the benefit transferred only to near–near tasks and the findings of near–far and far–far transfer were inconclusive which may be due to the design of the study and/or the sample size of the two groups.

Table 1
Studies assessing Cognitive flexibility as a component of Executive Function

Author Year, Country	Sample and size	Aim	Research Design	CF Measures & Other Measures	Main Findings
Karp, <i>et al</i> 2008	N=56 patients (mean age 76.1 years)	Investigate the effects of persistent pain on Mental flexibility,	Cross sectional	Trail Making Test of the Delis-Kaplan Executive Function System • Digit Symbol Subtest of the WAIS -III	Severe Pain was associated with increased impairment on Number- Letter Switching.
Hull, <i>et al</i> 2008 Texas	N=100 adults (80 female and 20 male) mean age = 60.24	Understanding the organization of executive functions	Explorative study	• local-global verbal & nonverbal task; • Wisconsin Card Sorting Test; • Tower of Hanoi task	CFA identified robust Shifting and Updating factors.
Davis, <i>et al</i> 2010 Canada	N=135 women aged 65 -75 years, Commu- nity dwelling	Association with health related quality of life	A secondary analysis of community- dwelling older women (Correlation study)	Trail Making Test (Part B) Stroop Test; Digits Verbal Span Backwards Test	Set shifting as measured by Trail Making Test (Part B) was independently associated with QALY's after accounting for age, co- morbidities, general mobility, and global cognition.
Coubard, <i>et al</i> 2011	N=110 elderly	The impact of contem- porary dance (CD) improvisation on attentional control/older adults, as compared to fall prevention and Tai Chi Chuan.	Intervention study	Stroop test; Rule shift cards test.	Contemporary Dance enhanced switching but not setting or suppressing attention. Fall prevention and Tai Chi Chuan, on the other hand, had no impact.
Verstynen, <i>et al</i> (2012)	N= 179 (Mean age = 66 years)	• Association between volume of basal ganglia study	Cross Sectional	• Task switching(verbal fluency); • <i>Flanker Task</i>	The higher cardiorespiratory fitness predicts better cognitive flexibility in

older adults through greater grey matter volume in the dorsal striatum.

and cardiorespiratory fitness levels.
 • Its prediction on cognitive flexibility in older adults.

Dai, <i>et al</i> (2013)	N= 48 (mean age = 68.89 ± 3.86 -years)	Relationship between exercise mode and executive function. Its effect on behavior and neuroelectric activity.	Cross sectional	modified task-switching paradigm was used and controlled via Neuroscan Stim software	The exercise groups, regardless of the exercise mode, exhibited faster reaction times in both global and local switches regardless of within-task condition.
Johnco, <i>et al</i> (2013)	N=40 (mean age= 68.07)	The impact of cognitive flexibility on the abilities of elderly in learning new cognitive restructuring skills.	Intervention study with a single session task completion	Sub tests of WAIS –IV; Wisconsin Card Sorting Test; TMT –B; COWAT; Stroop Color-Word Test, Ruff Figural Fluency Test	Cognitive flexibility had an impact on the ability of learning cognitive restructuring.
Lopes & Argimon 2016 Brasil	N= 83 Elderly grouped into (EG=45) (GC=38)	Measuring the impact of cognitive training with emphasis on executive functions, by comparing an Experimental and Control group.	quasi-experimental design with pre- and post-testing	Wisconsin Card Sorting Test (WCST)	There was a significant difference in the number of Completed categories of WCST between Experimental and Control group.
Schättin <i>et al</i> 2016 Switzerland	N=27 Elderly, Mean age 79.2±7.3 years	To compare exergame, with balance training on relative power (RP) of EEG frequencies over the PFC, Executive Function, and gait performance.	Randomized-Control study. Pre vs Post Interventions Study	• The set shifting/flexibility task from the battery of Test for Attentional Performance • Spatio-Temporal Gait parameters were measured by Physilog	The EEG measurements showed that theta R P significantly decreased in favour of the exergame group.

Anderson <i>et al</i> (2017)	N= 37 (age ranges from 50-85 years)	Investigating the probable relationship between cognitive flexibility, gut microbiome composition and sleep quality, in healthy elderly.	Cross sectional study	Stoop Colour word test	There was a probable relationship between sleep quality, gut microbiome composition, and cognitive flexibility in healthy elderly.
Hirsiger <i>et al</i> 2017 United States	N=200 healthy older adults; mean age = 70 years (106 women, 94 men).	Investigated the association between macro-structural and Micro-structural White Matter properties of WMH & Normal appearing White Matter executive functions.	Cross Sectional Study	• Trial Making Test (TMT A & B) • MRI • Diffusion Tensor Imaging DTI	Task-switching performance was predicted by micro structural Characteristics rather than the size of the frontal lobe WMH. In contrast, task-switching was linked to volume but not diffusion properties of WMH in the parietal lobe.
Ilhe, <i>et al</i> (2017)	N=2812 (mean age = 77.9 years)	Investigated the relationship of obesity to cognitive flexibility and its interplay with key correlates of cognitive reserve	Cross sectional study	• TMT -A (processing speed) • TMT -B (Cognitive flexibility)	Lower verbal ability, processing speed, and cognitive flexibility were all found to be associated with obesity.
Entezari <i>et al</i> (2018)	N=126 Elderly	To determine the effect of physical activity on cognitive flexibility and perfectionism in older adults.	causal-comparative research design	• Dennis and Vander Wal's Cognitive Flexibility Inventory (2010)	In three groups of senior people with low, high, and moderate physical activity levels, there were significant differences in the relationship between perfectionism and cognitive flexibility.
Chambon & Alscio-Lautier 2019 France	N=15; mean age=74.5±2.1. elderly	Examined the effect of a multifactor cognitive training programme on executive functions in older adults.	Randomized control trail with pre and post intervention	• Trial Making Test (B-A Scores); • Tower of Hanoi • Stroop colour word test; • semantic and first letter fluency tasks of Cardebat	Significant improvements in switching and inhibition of irrelevant stimuli were discovered.

Mekari <i>et al</i> 2020 Canada	N=69 older adults (age: 68 ± 7 years)	To test whether the aerobic exercise training (HIIT or MICT) would improve cognitive function more than a non-aerobic RT group.	Experimental Design	- computerized modified Stroop Task - Maximal Continuous Graded Exercise Test	HIIT, but not MICT or RT, improved cognitive flexibility in older adults despite similar improvements in cardiorespiratory fitness.
Shende <i>et al</i> 2021 USA	N=39 elderly (21 unaided mild hearing loss & 18 age- normal hearing controls.	Examined cognitive flexibility, and inhibition in elderly with unaided mild hearing loss /ARHL & age-normal hearing (NH) controls.	Cross sectional and comparative study	- Verbal Fluency test, - Letter Fluency; - TMT-B, - Delis-Kaplan Executive Function System - Stroop task - A Comprehensive Audiological Evaluation	Poorer peripheral and central hearing was associated with poorer cognitive flexibility and inhibitory control.

- EEG: electroencephalographic
- PFC: prefrontal Cortex
- WMH: white matter hyperintensity

Table 2
Studies assessing Inhibitory Control as a component of Executive Function

Author, Year, Country	Sample and size	Aim	Research Design	IC Measures & Other Measures	Main Findings
Bakos <i>et al</i> 2008 Brasil	N=20 Elderly; (10 young elderly $M = 62$ years) (10 oldest old $M = 80$ years)	Studied differences in the performance of young elderly and oldest old in tasks of cognitive flexibility/inhibition, selective attention/working memory, premorbid intelligence /semantic knowledge and decision making	Quasi-experimental control design with posttest only.	- Digit Span Subtest, - Vocabulary Subtest, - Stroop Test, - Iowa Gambling Task (IGT)	Young elderly reached more favourable scores in the Decision Making Test and difference in learning process of each group was observed
Hull <i>et al</i> 2008 Texas	N=100 adults (80 female and 20 male) with mean age=60.24	Studied the organization of Executive functions	Explorative study.	Nonverbal & verbal Stroop task; antisaccade task; Tasks of Cognitive flexibility; working memory; Wisconsin Card sorting test and Tower of Hanoi task	Conformatory factor analysis revealed that the Inhibition factor did not emerge, and there was no evidence for verbal or nonverbal factors.
Davis <i>et al</i> 2010 Canada	N=135 women aged 65-75 years, Community dwelling.	Examined whether executive functions are independently associated with health related quality of life in older women	A secondary analysis of community-dwelling elderly women.	- Stroop Test; - Trail Making Test (Part B) - Digits Verbal Span Backwards Test; - EQ-5D used to assess the health state utility value	Stroop Colour-Word test was not significantly associated with QALYs calculated from the EQ-5D.
Antón <i>et al</i> , 2016 Spain	1 st substudy: 48 elderly (24 Bilinguals, 24 Monolinguals). 2 nd substudy: 70 elderly bilinguals.	- Testing the effects of bilingualism on elderly. - Does bilingualism makes any benefits more salient in lifelong bilingual elderly.	Explorative and comparative study	Verbal and Numerical stroop task,	No modulation in any of the indices due to Language 2 proficiency was found.

Lopes & Argimon 2016 Brazil	Elderly N= 45 in Experimental and N=38 in Control group.	Measured the effects of cognitive training with emphasis on executive functions, by comparing an Experimental to a Control group.	quasi-experimental; correlation and comparative study	• Stroop Colors word Test • Go/No-Go Task	• Minimal errors committed by Elderly indicated positive effect of cognitive training. • No significant difference found between 2 groups in inhibition tasks.
Schättin <i>et al</i> 2016 Switzerland	N=27 Elderly with Mean age 79.2±7.3 years	Compared conventional balance training with exergame, on the relative power (RP) of electroencephalographic (EEG) frequencies over the Pre frontal cortex, executive function and gait performance.	Randomized-Control study. Pre vs Post Interventions: Exergame and Balance training	• Go/no go task • EEG • Spatio-Temporal Gait parameters were measured by Physilog	• Theta R P significantly decreased in favour of exergame. • pre-vs-post-test intervention indicated improved inhibitory control in both conditions within the exergame.
Wilkinson and Yang 2016 Canada	N=48 healthy elderly evenly assigned in practice group and no-contact control group.	Investigated the plasticity of inhibition, as indexed by practice effects of inhibition tasks and the associated transfer effects, with a multiple task approach.	Experimental design with pre and post test.	• Local-Global; N-Back; Go-No Go tasks; • Reading with Distraction; Directed Forgetting; Stroop test; Corsi Block Word List Recall; Letter Series; Digit Symbol; Short Blessed Test.	All three inhibition tasks demonstrated significant improvement across practice sessions, suggesting practice-induced plasticity. The advantage, however, only transferred to the near-near tasks.
Hirsiger <i>et al</i> 2017 United States	N=200 healthy elderly with Mean age 70.54 ± 4.88 years (106 women, 94 men)	Investigated the association between macrostructural and microstructural White Matter properties per cerebral lobe with core elements of executive function.	Cross Sectional Study	• MMSE • Computerized version of the Stroop task; • MRI • Diffusion Tensor Imaging	There was no significant association between inhibition performance and white matter Properties in White Matter Hyper intensities or in Normal Appearing White Matter.
Gamage <i>et al</i> 2018 Sri Lanka	N= 237 elderly with mean age 71.11 ± 6.44 years	Evaluated the association of cognition and executive functions: working memory and inhibitory control with perceived Quality of life (QoL) in elderly dwelling in residential aged care facilities.	Correlation Study	• Colour word Stroop test; • Stop signal; • go/no-go tasks; • WHOQoL scale	The Psychological health and Physical health domain and total QoL demonstrated negative but weak correlation with Stroop. Stop signal and Go/No-Go task errors.

Chambon & Alescio-Lautier 2019 France	Elderly (N=15) with mean age= 74.5±2.1 assigned into Experimental; Leisure and; Control groups.	Examined the impact of a multifactorial cognitive training program on executive functions in older adults.	Randomized control trial with pre and post intervention	Clinical Dementia Rating scale; Stroop colour word test; Trail Making Test(B-A Scores); Tower of Hanoi; Semantic and first letter fluency tasks of Cardebat.	Significant improvements were found for switching and inhibition of irrelevant stimuli.
Yang <i>et al</i> 2020 United States	N=26 healthy Elderly	Explored possible neurological mechanisms related to the effects of Tai Chi Chuan TCC interventions on inhibitory control in elderly.	Randomised Controlled with pre Vs. post intervention of Tai Chi Chuan and original Physical activity	Flanker Task MMSE; fNIRS	Post-intervention showed significant differences for incongruent flankers only for TCC intervention group. Faster RTs were observed for the incongruent flankers in TCC group than in control group.
Shende <i>et al</i> 2021 USA	N=39 Elderly (21 with age-related sensorineural hearing loss and 18 controls)	Examined cognitive flexibility, and inhibition in elderly with unaided mild Hearing Loss ARHL and 18 age- and education matched normal hearing (NH) controls.	Cross sectional and comparative study	• Stroop task ; • Go/NoGo tasks; • Montreal Cognitive Assessment; • Comprehensive Audiological Evaluation	ARHL group took significantly longer to complete Stroop task and had higher error rates on Go/No Go tasks relative to the NH controls.

Table 3
Studies assessing Working Memory as a component of Executive Function

Author, Year, Country	Sample and size	Aim	Research Design	WM Measures & Other Measures	Main Findings
Insel <i>et al</i> 2006 Tucson	N=95 older adults with Mean age=78 years	Investigated the association between cognitive processes and medication adherence among community-dwelling older adults.	Co-relational study	- Sub tests of Wechsler Memory Scale- III (WMS-III), - California verbal learning test	Composites scores measuring executive function-Working Memory and memory were significantly related to medication adherence.
Bugos <i>et al</i> 2007 USA	N=31 musically naïve community improved performance on the TMT -dwelling elderly aging 60–85 years	The experimental group significantly improved performance on the TMT cognitive intervention to prevent or maintain cognitive skills in normal aging.	Evaluated the role of Musical instruction as a potential post training.	Trial Making Test Part A & B	Randomised control study with pre and and Digit Symbol measures as compared to healthy controls.
Bakos <i>et al</i> 2008 Brasil	N=20 older women assigned into two groups	Studied differences in the performance of the young elderly and oldest old in tasks evaluating cognitive flexibility/inhibition, selective attention/Working Memory and decision making	Cross sectional and preliminary comparative study	- Subtests of WAIS-III; - Stroop Test; - Iowa Gambling Task (IGT) assessing Decision Making	- No differences found between young elderly and the oldest old in selective attention, short-term memory, and working memory. - They differed significantly only in decision making Ability.
Hull <i>et al</i> 2008 Texas	N=100 adults (80 female and 20 male) with mean age=60.24	Studied the organization of components of Executive functions	Explorative study	- Nonverbal & verbal Stroop task; - antisaccade task; - Tasks of Cognitive flexibility; working memory - Wisconsin Card sorting test and Tower of Hanoi task	- Confirmatory Factor Analysis identified robust Shifting and Updating factors with no evidence for verbal and nonverbal factors. - Structural Equation Model showed that the Updating was the best predictor of performance on

Davis <i>et al</i> 2010 Canada	N=135 women aged 65 to 75 years, community- dwelling	Determining the independent association of executive functions with health related quality of life in older women after adjusting for known covariates.	Correlation study	Trail Making Test Part B, Verbal Digits Backward Test, Stroop Colour-Word Test	Working Memory was found significantly associated with Quality of life in elderly women.
Lopes and Argimon 2016 Brazil	N=83 elderly 16 male & 67 the groups in working 2016 female.	To determine the impact of cognitive training with emphasis on executive functions, by comparing an Experimental to a Control group.	Experimental study	Subtests of WAIS-III; Rey Complex in which Cognitive	Significant difference was found Figures; Trail Making Test; between
Schättin <i>et al</i> 2016 Switzerland	N=27 with Mean age 79.2±7.3 years	Comparing conventional balance training exergame, on the relative power (RP) of electroencephalographic (EEG) frequencies over the Pre-frontal Cortex, executive function, and gait performance.	Randomized- Control design. Pre vs. Post Interventions with Exergame & Balance training	Sternberg Paradigm; Verbal Fluency tasks; Rey Auditory-Verbal Learning Test	memory after training indicating positive effect of cognitive training on executive functions.
Gamage <i>et al</i> 2018 Sri Lanka	N=237 elderly with mean age 71.11 ± 6.44 years	The association of Working Memory and inhibitory control with the perceived Quality of Living of a sample of elderly people dwelling in residential aged care facilities in Southern Province of Sri Lanka.	Correlation Study	Verbal and visuo-spatial Working Memory tasks. • WHOQOL-Bref short version Questionnaire was used to assess the Quality of Living (QoL).	Domains of psychological health, physical health and total QoL demonstrated positive correlation with Verbal and Visuo-spatial working memory. But it was a weak correlation.
Platsikas <i>et al</i> 2018 USA	N=754 Chinese speakers' age ranging from 58 to 89 years.	Examined the effects of ageing, sex and education on Working Memory and its abilities.	Cross sectional study	<i>Digit n-back</i> task	• Age negatively impacted working Memory abilities as did load. • In contrast, education level positively associated with working memory. Moreover, both age and education interacted with sex.

Matysiak <i>et al.</i> (2019) United States	N=85 elderly age from 55–81 years: 55 females, 30 males	The impact of working memory training on variety of cognitive tasks performance and the impact of initial working memory capacity on the training efficiency.	Pre & Post, 5 weeks Digit Span task training on adaptive N-back task for experimental, and memory quiz for control group.	• Post-intervention group found independent improvements across all cognitive tests, except for inhibition and Short term memory • Multi-level analyses enabled examining intra and inter individual differences.
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Likewise, the impact of cognitive training was assessed, and the elderly in both experimental and control groups did not differ significantly in the Stroop test and Go no go task, even after attaining cognitive training as an intervention (Lopes & Argimon 2016). On the other hand, multi-factorial cognitive training showed improvements in inhibiting irrelevant stimuli in older adults. This study revealed engaging only in leisure-type cognitive activity is insufficient to improve the highly regulated process of resisting interference (Chambon, and Alescio-Lautier 2019).

Physical activities such as exercise-based video games called Exer game training showed improvement of inhibitory control after post-test and the EEG measurements showed theta Relative Power significantly got decreasing in the experimental group of elderly (Schättin, *et al.*, 2016). Likewise, training of Tai Chi Chuan training exhibited a fewer number of errors with a faster reaction time in the flanker test in post intervention assessment of the experimental group indicating a positive impact on Inhibitory control (Yang, *et al.*, 2020).

Taking into account neural substrates, a study conducted by Hirsiger, *et al.*, (2017) found no association between inhibition performance and white matter Properties in White Matter Hyperintensity or Normal Appearing White Matter. But because of the impact of physical impairment, elderly with age-related hearing loss took significantly longer time to complete the Stroop test and higher errors in the Go No Go task, indicating age-related hearing loss negatively affects inhibitory control (Shende, *et al.*, 2021).

Apart from these factors, quality of life was also studied with inhibitory control in the elderly and only two studies with contradictory results were found. Davis, *et al.*, (2010) examined the association between inhibitory control and health-related quality of life but the Stroop task did not improve the model significantly even after accounting for age, group, education, waist girth, functional comorbidity index, general mobility, and global cognition which indicated no independent association. Differently, Gamage, *et al.*,

(2018) found the domains of psychological health and physical health; also the overall quality of life demonstrated a negative though weak correlation with inhibitory control.

Interestingly, Antón,*et al.*, (2016) observed the effects of bilingualism on inhibitory control by conducting two experiments: comparing the monolingual and bilingual elderly; and studied the impact of language-2 proficiency on inhibitory control but the results specified no difference between both monolingual and bilingual groups and there was no modulation in any of the indices due to Language 2 proficiency indicating no impact of bilingualism on inhibitory control.

Working memory (WM)

10 studies (Table no-3) were found that assessed Working memory with other related factors. The decline of working memory in ageing was observed in two studies among which Bakos,*et al.*, (2008) found no difference in working memory when compared to two groups i.e young elderly and oldest elderly. On the contrary, Pliatsikas, *et al.*, (2018) found, that with increasing age, males demonstrated a steeper working memory decline compared to females; with increasing education, females showed greater working memory gains than males signifying the impact of age, sex, and education on working memory in older adults.

The organisation of executive functions studies by Hull, *et al.*, (2008), where confirmatory Factor Analysis identified robust emergence of updating and shifting factors. Also Structural Equation Model showed updating was the best predictor of performance in complex cognitive tasks.

Insel, *et al.*, (2006) investigated the association between working memory and medication adherence in the elderly, the composite score of executive functions and working memory measures were significantly related to adherence indicating a strong association.

In several types of research, working memory was combined with cognitive variables. Bugos, *et al.*, (2007) looked at the impact of music instruction as a possible intervention to improve working

memory in the elderly, and the findings revealed that Individualized Piano Instruction might be a useful cognitive intervention for age-related cognitive decline. Similar to that, Lopes and Argimon (2016) found a positive impact of cognitive training on tasks of working memory in the experimental group. Poles apart, Matysiak, *et al.*, (2019) assessed the impact of working memory training on other cognitive tasks where the working memory was studied as an independent variable and found significant independent improvements in cognitive tasks except inhibition and short-term memory.

Related to physical exercise, only one study assessed a video game based called Exer game on working memory where working memory was one of the components of executive functions and found significant improvement after the intervention of Exer game indicating the positive impact of the intervention on working memory (Schättin, *et al.*, 2016).

Regarding the association between working memory and quality of living in the elderly, two studies were reviewed with similar findings. Davies, *et al.*, (2007) established a significant association between working memory and Health-Related Quality of Living. Supporting it, Gamag, *et al.*, (2018) found a significant positive correlation between working memory with psychological health domain; physical health domain, and overall quality of living in the elderly.

Executive function as a single factor (EF)

Executive function was measured as a single unitary factor by many researchers and this current article found 10 studies (Table no. 4) on the elderly in which four of them assessed executive functions' association with physical tasks (balance gait, dual task, walking speed). Ble, *et al.*, (2005) tried to see the association of executive functions with walking speed but could not find significant relation with walking speed at a usual pace on a 4 m course but its association was found to be more in the lowest tertile for 7-m obstacle course walking speed. In contrast, Iersel (2008) discovered a relationship between executive functions and stride length variability, and

Table 4
Studies assessing Executive Function as a single component

Author, Year, Country	Sample and size	Aim	Research Design	EF Measures & Other Measures	Main Findings
Ble <i>et al</i> 2005 New York	N= 926 elderly aged 65 & above non-demented	Association between performance on psychological tests of Executive Functions and performance on lower extremity tasks with different attentional demands.	Cross sectional study	· Trial Making Test Part A&B · Walking speed on a 4-m course at usual pace and on a 7-m obstacle course at fast pace.	Participants with poor Delta TMT and with intermediate Delta TMT performance were more likely to be in the lowest tertile for 7-m obstacle course walking speed.
Insel <i>et al</i> 2006 Tucson	N=95 (mean age=78) community dwelling older adults	Investigate the association between cognitive processes and medication adherence	Co-relational study	Wisconsin Card sorting test	Composites scores measuring Executive Function (working memory) and memory were significantly related to medication adherence.
Bugos <i>et al</i> 2007 USA	N=31 musically naïve community-dwelling elderly (age: 60–85 years)	Evaluate the role of Musical instruction as a potential cognitive intervention to prevent or maintain cognitive skills in normal aging.	Randomised control study with pre and post training in Experimental (16) and Control (15) groups	· Trial Making Test Part A&B · Subtests of Wechsler Adult Intelligence Scale (WAIS) III	The experimental group significantly improved performance on TMT and Digit Symbol of WAIS-III as compared to healthy controls.
Johnson <i>et al</i> 2007 San Francisco	N = 7717 community dwelling elderly women (mean age 73.3 years).	Compare the contribution of impairment in Executive Functions or global cognitive function to predicting functional decline and mortality in elderly women	Cross sectional study with 6-year follow-up	· Trail Making Test B [Trails B] · Activities of Daily Living [ADLs] and Instrumental ADLs [IADLs]	· Executive function impairment in women had significant correlation with worse daily living activities (ADL & IADL) cross-sectionally, and over 6 years. · Women with executive impairment also had an increased risk of mortality.

Carlson <i>et al</i> 2008 USA	N=149 Elderly Assigned in 2 groups: Experience Corps (EC) and wait-list control arm.	Explore the Effects of an "Everyday" Activity Program on Executive Functions and Memory in Elderly: Experience Corps (EC)	Randomized trial with pre and post into 2 groups	Trail Making Test Rey-Osterich Complex Figure Test	Experience Corps showed improvements in Executive functions and memory, relative to matched controls. Experience Corps with impaired baseline showed greatest improvements at follow-up.
Iersel, 2008 The Netherlands	N = 100 community living elderly (mean age 80.6)	Examined the association between two different EF and measures of both gait and balance, with and without two different cognitive dual tasks.	cross-sectional study	Trail Making Test (TMT) Parts A and B; Stroop Color Word Test;	Executive Functions were found linked with only stride length variability and mediolateral trunk sway during performance of animal naming as the dual task.
Lima-Silva 2012 Brazil.	N = 43 elderly aging above 55 years assigned into Experimental (26) Control (17) groups	Investigating the effect of cognitive training on Executive Functions among healthy elderly.	cross-sectional study with pre and post intervention	Sub tests of Weschler Adult Intelligence Scale, Clock Draw-ing Test, TMT Part A.	Findings showed no effect cognitive training on performance on the Executive Functions tests.
Nouchi 2012 The Netherlands	N = 28 elderly grouped into two, The Brain Age (14), The Tetris (14)	Investigate the impact of the brain training game (Brain Age) on Cognitive Functions in the elderly.	Randomised Controlled Trail design	Frontal Assessment Battery at bedside (FAB) Trail Making Test-B (TMT-B)	Effects of brain training game transferred to Executive Functions & processing speed. However, it showed no transfer effect on any global cognitive status.
Parikh & Shah 2017 India	N = 100 elderly age ranging from 65-75 years	The relationship between Executive functions and dual- task physical performances To confirm Executive functions as a useful predictor for functional limitation or disability process in elderly.	Cross sectional Study	Trail Making Test- B; Dual-task physical performances of walking (gait speed)	A significant correlation was found between Executive functions and dual task physical performance.

Porane Clark <i>et al</i> 2018 Switzerland	N = 157 community dwelling elderly aged 76-91 years participated at baseline, among which 103 completed two year follow-up.	· To see the associations between Executive Functions and life-space mobility. · Examined if perceived walking difficulties, lower extremity performance, and transportation difficulties explain the association.	cross-sectional and longitudinal	Trail Making Test - Delta scores.	· Poor Executive Function was associated with lower life-space mobility. · Also it showed steeper decline over 2-year follow-up, but the difference was not significant.
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mediolateral trunk sways during the dual task of animal naming. Likely Parikh and Shah (2017) also found a significant correlation between the dual task and executive functions.

Apart from physical tasks, the impact of cognitive tasks on executive functions was also observed. Bugos, *et al.*, (2007) tried to see the impact of music instruction as an intervention but there were no improvements in executive functions. Also, Lima-Silva, *et al.*, (2012) conducted an intervention study where cognitive training showed no impact on tasks of executive functions. In Contrast, Nouchi, *et al.*, (2012) found a significant impact of brain training games on the executive functions of the elderly.

Other studies such as Insel, *et al.*, (2006) found a strong association between executive functions and medication adherence in the elderly.

In addition, concerning daily living activities, Johnson, *et al.*, (2007) found an association between daily living activities and cognitive flexibility, also the mortality rate was high in women with executive function impairment. Supporting these findings Carlson, *et al.*, (2008) conducted an 'Everyday' activity programme on the elderly, and the results indicated that the programme had a significant positive impact. On the other hand, Poranen Clark, *et al.*, (2018) found Individuals with poor executive functions had lower life-space mobility compared to those with good executive functions. During follow up elderly with poor executive functions at baseline showed a steeper decline indicating a strong association between executive functions and life-space mobility.

Discussion

The current study aimed at reviewing articles on the decline of Executive functions in the elderly that are published in the last 15 years. It also had an objective of understanding if there is any pattern of decline within different age groups of the elderly. Though as a neuropsychological construct, executive functions have long been considered a unitary, general purpose higher-order ability, frequently

measured with a single, complex “frontal lobe task” (e.g., Wisconsin Card Sorting Test; Friedman, *et al.*, 2008), it also has been characterized more accurately as a collection of multiple related but separable or dissociable executive processes (Teuber, 1972). Therefore, some of the studies have treated it as a separable process by assessing its variables independently and some have studied it as a single complex unitary higher-order ability.

To our goal, age was found to harm working memory, education has a positive association. Furthermore, both age and education interact with sex, with males having a greater decline in old age than females, and females having greater benefits associated with more education than males. These findings reveal important aspects of the nature of working memory in old age (Pliatsikas, *et al.*, 2018). However, while age did not affect working memory, cognitive flexibility, and inhibitory control between young elderly and oldest elderly, it did affect the executive functions as measured by the decision-making skills. This confirms that age, as a categorical but also as a continuous variable, influences executive functions as measured by decision-making skills, resulting in reductions in individual performance beginning in the sixth decade of life (Bugos, *et al.*, 2008).

Regarding the organization of executive functions in older adults, shifting and updating strongly emerged in confirmatory factor analysis except for inhibitory control. The failure of inhibitory control does not emerge as a strong indicator may rest on two reasons, first is the lack of cohesiveness among the inhibition measures used (i.e., verbal and nonverbal Stroop and antisaccade). And second is the fact that all the Inhibition measures involved prepotent response inhibition, and none required resistance to proactive interference (Hull, *et al.*, 2008).

On the other hand, some studies focused on interventions that could either improve executive functions or slow down the decline in old age. These interventions were either physical

activities or cognitive skills training. Concerning physical activities, physical tasks such as dance and multimodal exercises were found to have a positive impact on cognitive flexibility, working memory, and inhibitory control (Coubard, *et al.*, 2011; Dai, *et al.*, 2013; Schättin, *et al.*, 2016; Mekari, *et al.*, 2020). Similarly, cognitive interventions such as multimodal cognitive training rather than simple cognitive tasks have improved all three executive functions (Johnco, *et al.*, 2013; Lopes & Argimon 2016; Chambon, and Alescio-Lautier 2019). Hence it indicates that multimodal physical activities and multimodal cognitive training both positively impact the executive functions of the elderly.

When it comes to the association of executive functions with other factors, health-related factors were studied in an elderly population where microbiome and sleep quality, obesity, the intensity of pain, age-related hearing loss, and cardio-respiratory fitness are all found to be associated with the decline of executive functions (Karp, *et al.*, 2008; Anderson, *et al.*, 2017; Ihle, *et al.*, 2017; Shende, *et al.*, 2021; Verstynen, *et al.*, 2012). Also, Neural substrates such as White matter hyperintensity were found to be associated with the executive functions in the elderly (Hirsiger, *et al.*, 2017).

Relating to quality of life and medication adherence, there are differential findings with all the three components of Executive Functions, Cognitive flexibility, and working memory found to be positively correlated with quality of living, but the inhibitory control did not (Davis, *et al.*, 2010). On the other hand, Gamage, *et al.*, (2018) found a weak though the significant correlation between the quality of life with inhibitory control and working memory in the elderly. Similarly, a study that assessed Executive functions as a single ability, has also found the association of executive functions with daily living activities in older adults (Johnson, *et al.*, 2007; Carlson, *et al.*, 2008). Apart from that, Insel, *et al.*, (2006) found medication adherence is associated with working memory in the elderly. This result is consistent with prefrontal cortex theory which proposes that cognitive control stems from the

active maintenance of patterns of activity in the prefrontal cortex that represents goals and means to achieve them.

Regarding the assessment of executive functions and other cognitive assessments, the majority of the studies have used the Mini-Mental Status Examination for screening and assessing general cognition. Similarly Stroop test and Go no go tasks for inhibitory control, Trial Making Test (A & B); also Trial Making Test delta scores for cognitive flexibility, and sub-tests of Wechsler Adult Intelligence Scale III for working memory were used in the majority of the studies reviewed. This indicates that these tests are highly sensitive in tapping those specific abilities of executive functions in the elderly.

Review of studies comparing young and old age, importantly more studies comparing different age groups within the elderly can aid in understanding the pattern of decline which would further help in formulating techniques or measures to regulate or slow down the decline of executive functions in the elderly.

Conclusion

Studies published during the last decade assessing executive functions individually as well as assessing them as a single unitary factor were reviewed. Only two studies were found that assessed the decline which signifies that age is a categorical but also a continuous variable, it is a factor that influences executive functions in the elderly. Further Multi-modal cognitive training, physical activities, and multi-modal exercises were found to improve Executive Functions. While, factors like quality of living, daily activities of living, health-related factors, and neural substrates such as white matter hyper-intensities were all found to be associated with Executive Functions in the elderly. This systematic review has focused on declining executive functions in the elderly with no cognitive impairment. Therefore, it can be suggested that future studies can focus on the decline of executive functions in elderly with cognitive impairment. As Executive function is a broad concept, only studies published in the last 15 years were reviewed. Studying each executive function separately without

restricting the period may facilitate understanding the pattern of decline in a better way.

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References

- Anderson, J. R., Carroll, I., Azcarate-Peril, M. A., Rochette, A. D., Heinberg, L. J., Peat, C., and Gunstad, J. (2017). A preliminary examination of gut microbiota, sleep, and cognitive flexibility in healthy older adults. *Sleep medicine*, 38, 104-107.
- Anderson, V., Jacobs, R., & Anderson, P. J. (Eds.). (2010). *Executive functions and the frontal lobes: A lifespan perspective*. Psychology Press.
- Antón, E., García, Y. F., Carreiras, M., and Duñabeitia, J. A. (2016). Does bilingualism shape inhibitory control in the elderly?. *Journal of Memory and Language*, 90, 147-160.
- Baddeley, A. D., and Hitch, G. J. (1994). Developments in the concept of working memory. *Neuropsychology*, 8(4), 485-493.
- Bakos, D. S., Couto, M. C. P. D. P., Melo, W. V., Parente, M. A. D. M., Koller, S. H., and Bizarro, L. (2008). Executive functions in the young elderly and oldest old: a preliminary comparison emphasizing decision making. *Psychology & Neuroscience*, 1(2), 183-189.
- Bjorklund, D. F., and Harnishfeger, K. K. (1995). The evolution of inhibition mechanisms and their role in human cognition and behavior. In F. N. Dempster & C. J. Brainerd (Eds.), *Interference and inhibition in cognition* (pp. 141-173). San Diego, CA: Academic Press.
- Ble, A., Volpato, S., Zuliani, G., Guralnik, J. M., Bandinelli, S., Lauretani, F., and Ferrucci, L. (2005). Executive function correlates with walking speed in older persons: the InCHIANTI

- study. *Journal of the American Geriatrics Society*, 53(3), 410-415.
- Brainerd, C., and Reyna, V. (1993). Memory independence and memory interference. *Psychological Review*, 100, 42-67.
- Bugos, J. A., Perlstein, W. M., McCrae, C. S., Brophy, T. S., and Bedenbaugh, P. H. (2007). Individualized piano instruction enhances executive functioning and working memory in older adults. *Aging and mental health*, 11(4), 464-471.
- Carlson, M. C., Saczynski, J. S., Rebok, G. W., Seeman, T., Glass, T. A., McGill, S., and Fried, L. P. (2008). Exploring the effects of an “everyday” activity program on executive function and memory in older adults: Experience Corps®. *The Gerontologist*, 48(6), 793-801.
- Chambon, C., and Alescio-Lautier, B. (2019). Improved executive functioning in healthy older adults after multifactorial cognitive training targeting controlled processes. *Journal of Systems and Integrative Neuroscience*.
- Collins A, and Koechlin E. (2012). Reasoning, learning, and creativity: frontal lobe function and human decision making. *PLoS Biol.* 10:e1001293
- Coubard, O. A., Duretz, S., Lefebvre, V., Lapalus, P., and Ferrufino, L. (2011). Practice of contemporary dance improves cognitive flexibility in aging. *Frontiers in aging neuroscience*, 3, 13.
- Davis, J. C., Marra, C. A., Najafzadeh, M., and Liu-Ambrose, T. (2010). The independent contribution of executive functions to health related quality of life in older women. *BMC geriatrics*, 10(1), 1-8.
- De Luca, C., Wood, S., Anderson, V., Buchanan, J., Proffit, R., & Mahony, K., Pantelis, C., (2003). Normative data from the Cantab: Development of executive function over the lifespan. *Journal of Clinical and Experimental Neuropsychology*, 25, 242-254.

- Dempster, F. N. (1992). The rise and fall of the inhibitory mechanism: toward a unified theory of cognitive development and aging. *Developmental Review*, 12, 45-75.
- Diamond, A. (1990). The development and neural bases of memory functions, as indexed by the AB and delayed response tasks, in human infants and infant monkeys. *Annals of the New York Academy of Sciences*, 608, 267-317.
- Fisk, J., and Sharp, C. (2004) Age-related impairment in executive functioning: updating, inhibition, shifting, and access. *Journal of Clinical and Experimental Neuropsychology*, 26, 874-890.
- Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., and Hewitt, J. K. (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal of experimental psychology: General*, 137(2), 201.
- Gamage, M. W. K., Hewage, C., and Pathirana, K. D. (2018). Effect of cognitive and executive functions on perception of quality of life of cognitively normal elderly people dwelling in residential aged care facilities in Sri Lanka. *BMC geriatrics*, 18(1), 1-10.
- Hasher, L., and Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. *The Psychology of Learning and Motivation*, 22, 122-149.
- Hirsiger, S., Koppelmans, V., Mérillat, S., Erdin, C., Narkhede, A., Brickman, A. M., and Jäncke, L. (2017). Executive functions in healthy older adults are differentially related to macro-and microstructural white matter characteristics of the cerebral lobes. *Frontiers in Aging Neuroscience*, 9, 373.
- Hull, R., Martin, R. C., Beier, M. E., Lane, D., and Hamilton, A. C. (2008). Executive function in older adults: a structural equation modeling approach, *Neuropsychology*, 22(4), 508.
- Iersel, M. B. V., Kessels, R. P., Bloem, B. R., Verbeek, A. L., and Olde Rikkert, M. G. (2008). Executive functions are associated with gait and balance in community-living elderly people. *The*

Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 63(12), 1344-1349.

- Ihle, A., Mons, U., Perna, L., Oris, M., Fagot, D., Gabriel, R., and Kliegel, M. (2016). The relation of obesity to performance in verbal abilities, processing speed, and cognitive flexibility in old age: the role of cognitive reserve. *Dementia and geriatric cognitive disorders*, 42(1-2), 117-126.
- Insel, K., Morrow, D., Brewer, B., and Figueredo, A. (2006). Executive function, working memory, and medication adherence among older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 61(2), P102-P107.
- Johnco, C., Wuthrich, V. M., and Rapee, R. M. (2013). The role of cognitive flexibility in cognitive restructuring skill acquisition among older adults. *Journal of anxiety disorders*, 27(6), 576-584.
- Johnson, J. K., Lui, L. Y., and Yaffe, K. (2007). Executive function, more than global cognition, predicts functional decline and mortality in elderly women. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 62(10), 1134-1141.
- Karp, J. F., Reynolds III, C. F., Butters, M. A., Dew, M. A., Mazumdar, S., Begley, A. E., and Weiner, D. K. (2006). The relationship between pain and mental flexibility in older adult pain clinic patients. *Pain Medicine*, 7(5), 444-452.
- Keys, B., and White, D. (2000). Exploring the relationship between age, executive abilities, and psychomotor speed. *Journal of the International Neuropsychological Society*, 6, 76-82.
- Lehto JE, Juujärvi P, Kooistra L, Pulkkinen L.(2003). Dimensions of executive functioning: evidence from children. *Br. J. Dev. Psychol.* 21:59-80
- Lima-Silva, T. B., Fabrício, A. T., Silva, L. D. S. V., Oliveira, G. M. D., Silva, W. T. D., Kissaki, P. T., and Yassuda, M. S. (2012).

Training of executive functions in healthy elderly: Results of a pilot study. *Dementia & neuropsychologia*, 6, 35-41.

Lopes, R. M. F., and Argimon, I. I. (2016). Cognitive training in the elderly and its effect on the executive functions. *Acta Colombiana de Psicología*, 19(2), 159-176.

Lunt L, Bramham J, Morris RG, Bullock PR, Selway RP, Xenitidis, K., David, A S., (2012). Prefrontal cortex dysfunction and “jumping to conclusions”: bias or deficit? *J. Neuropsychol.* 6:65–78.

Matysiak, O., Kroemeke, A., and Brzezicka, A. (2019). Working memory capacity as a predictor of cognitive training efficacy in the elderly population. *Frontiers in aging neuroscience*, 11, 126.

Mejia, S., Pineda, D., Alvarez, L., and Ardila, A. (1998). Individual Differences in memory and executive function abilities during normal aging. *International Journal of Neuroscience*, 95, 271–284.

Mekari, S., Neyedli, H. F., Fraser, S., O’Brien, M. W., Martins, R., Evans, K., and Dupuy, O. (2020). High-Intensity Interval Training Improves Cognitive Flexibility in Older Adults. *Brain sciences*, 10(11), 796.

Miyake, A., Emerson, M. J., Padilla, F., & Ahn, J. C. (2004). Inner speech as a retrieval aid for task goals: The effects of cue type and articulatory suppression in the random task cuing paradigm. *Acta psychologica*, 115(2-3), 123-142.

Miyake, A; Friedman, NP; Emerson, MJ; Witzki, AH; Howerter, A; Wager, TD (2000). “The unity and diversity of executive functions and their contributions to complex ‘frontal lobe’ tasks: A latent variable analysis”. *Cognitive Psychology*. 41 (1): 49–100.

Monsell, S. (2003). Task switching. *Trends in cognitive sciences*, 7(3), 134-140.

- Nouchi, R., Taki, Y., Takeuchi, H., Hashizume, H., Akitsuki, Y., Shigemune, Y., and Kawashima, R. (2012). Brain training game improves executive functions and processing speed in the elderly: a randomized controlled trial. *PloS one*, 7(1), e29676.
- Parikh, H. S. K., and Shah, C. (2017). Relationship between executive function and dual task physical performance among older adults-a cross sectional study. *Int. J. Phys. Med. Rehabil*, 5(421), 10-4172.
- Pliatsikas, C., Verissimo, J., Babcock, L., Pullman, M. Y., Gleib, D. A., Weinstein, M., Goldman, N., and Ullman, M. T. (2019). Working memory in older adults declines with age, but is modulated by sex and education. *Quarterly Journal of Experimental Psychology*, 72(6), 1308-1327.
- Plumet, J., Gil, R., and Gaonac'h, D. (2005). Neuropsychological assessment of executive functions in women: Effects of age and education. *Neuropsychology*, 19(5), 566-577.
- Poranen-Clark, T., von Bonsdorff, M. B., Rantakokko, M., Portegijs, E., Eronen, J., Kauppinen, M., and Viljanen, A. (2018). Executive function and life-space mobility in old age. *Aging clinical and experimental research*, 30(2), 145-151.
- Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological review*, 103(3), 403.
- Schättin, A., Arner, R., Gennaro, F., and de Bruin, E. D. (2016). Adaptations of prefrontal brain activity, executive functions, and gait in healthy elderly following exergame and balance training: a randomized-controlled study. *Frontiers in aging neuroscience*, 8, 278.
- Shende, S. A., Nguyen, L. T., Lydon, E. A., Husain, F. T., and Mudar, R. A. (2021). Cognitive Flexibility and Inhibition in Individuals with Age-Related Hearing Loss. *Geriatrics*, 6(1), 22.
- Smith, E. E., and Jonides, J. (1999). Storage and executive processes in the frontal lobes. *Science*, 283, 1657-1661.

- Teuber, H.L. (1972). Unity and Diversity of Frontal Lobe Functions. *ACTA Neurobiologica Experimentalis*, 32, 615-656.
- Verstynen, T.D., Brighid Lynch, Destiny L. Miller, Michelle W. Voss, Ruchika Shaurya Prakash, Laura Chaddock, Chandramallika Basak, Amanda Szabo, Erin A. Olson, Thomas R. Wojcicki, Jason Fanning, Neha P. Gothe, Edward McAuley, Arthur F. Kramer, Kirk I. Erickson (2012). Caudate nucleus volume mediates the link between cardiorespiratory fitness and cognitive flexibility in older adults. *Journal of aging research*, 2012.
- West, R. L. (1996). An application of prefrontal cortex function theory to cognitive aging. *Psychological Bulletin*, 120, 27
- Wilkinson, A. J., and Yang, L. (2016). Inhibition plasticity in older adults: Practice and transfer effects using a multiple task approach. *Neural Plasticity*, 2016.
- Yang, Y., Chen, T., Shao, M., Yan, S., Yue, G. H., and Jiang, C. (2020). Effects of Tai Chi Chuan on inhibitory control in elderly women: An fNIRS study. *Frontiers in human neuroscience*, 13, 476.

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Anthropometric and Body Composition Characteristics in Geriatric Population with Special Reference to the Asian Indians : A Systematic Review

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ABSTRACT

The process of biological ageing is characterized by vast alternations in physiological and nutritional characteristics and shows immense variation in its onset and survival in different populations. Besides clinical examinations, anthropometric and body composition measurements hold a crucial role to monitor malnutrition, determining the doses of drugs, and examining the improvements after nutrition therapy. The present study aims to review the worldwide variation in anthropometry and body composition characteristics to assess the health and nutritional condition of the geriatric population with special reference to the Asian Indian population. 48 works of literature were retrieved using Google Scholar, PUBMED, and Research Gate and manual searching. Body mass index declined with age; waist-hip-ratio increased with age indicating abdominal obesity with

special notation among the males. Percentage body fat and fat mass increased with age predominantly in females. Nutritional, psychological, cardiovascular, and cardio-metabolic disorders and age-related hormonal alternations have significant impacts on the anthropometric and body composition characteristics.

Keywords : Anthropometry, Body Composition, Elderly, Nutrition, Asian Indians.

The process of biological ageing is characterized by vast alternations in the physiological and nutritional characteristics which lead to a significant reduction in height, weight, and eventually the body mass index (BMI). Moreover, the declined fat-free mass (FFM) and accumulation of fat mass (FM) in the process of ageing and the increased percentage of body fat (PBF) enhance the possibility of excess weight gain and obesity. The gained fat usually accumulates in the abdominal areas prompting obesity which is one of the conventional risk factors for several cardiovascular diseases (Milanoviæ *et al.*, 2011).

Nutritional disorders are common in the geriatric population exacerbating the risk of morbidity and mortality. Hence, besides the clinical examinations, anthropometric and body composition measurements hold a crucial role to monitor malnutrition, determining the doses of drugs, and examining the improvements after nutrition therapy (Ravaglia *et al.*, 1997).

With the gradual advancement in the medical sectors and increasing medical facilities, life expectancy has gradually increased for human beings. Over the decades, geriatric health has become an interesting research area however, information on this sector to date is not sufficient to comprehend the entire scenario. The present review is an attempt to enlighten the health and nutritional status of the geriatric population over the globe using anthropometric and body composition data.

Aim of the Study

The present study aims to review the worldwide variation in anthropometry and body composition characteristics to assess the health and nutritional condition of the geriatric population with special reference to the Asian Indian population.

Materials and Methods

Search strategy: We did a literature search using Google Scholar, PUBMED, and Research Gate to identify the relevant studies on the selected topic. The keywords used for the literature search are ‘anthropometry’, ‘body composition’, ‘old age’, ‘geriatric population’, and ‘elderly’. 48 papers have been systematically reviewed out of which 22 papers were retrieved from Google Scholar, 20 papers from PUBMED, 4 papers from Research Gate, and 2 papers by manual searching.

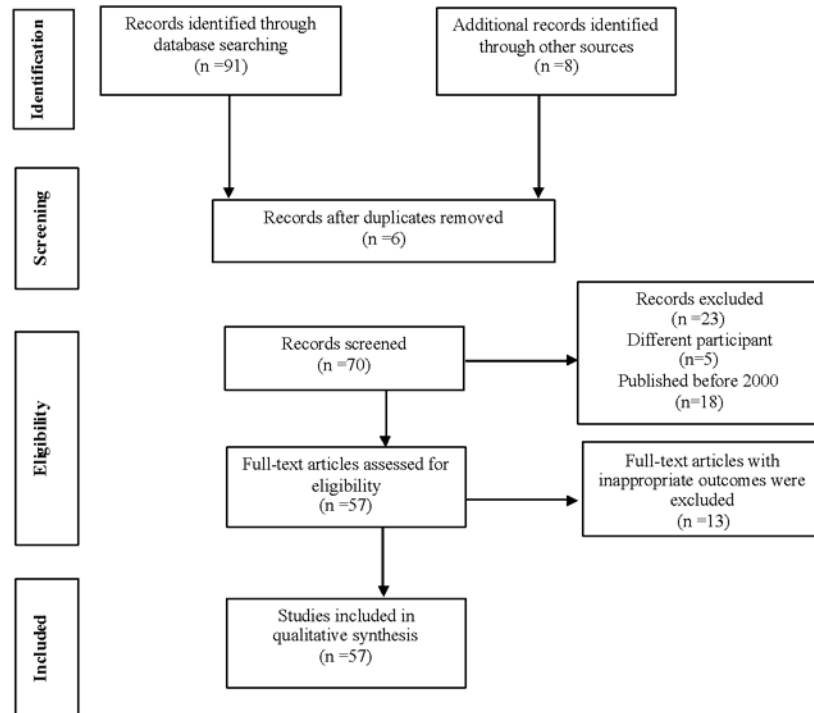
Inclusion and exclusion criteria: Papers have been selected from peer-reviewed journals published between 2000 and 2020. Papers with <100 subjects were excluded.

Selected Population: Individuals aged ≥ 55 years have been considered for the review.

Data extraction: Age, sex, and ethnic differences in body mass index (BMI), waist-hip ratio (WHR), percentage body fat (PBF), fat mass (FM), and fat-free mass (FFM) were denoted from the literature.

Outcomes measure: WHO criteria (2004) have been considered to assess nutritional status using BMI (Rangel Peniche DB, *et al.*, 2018), and WHR has been assessed using the WHO criteria (1998) (López-Ortega and Arroyo, 2015). All anthropometric values are shown in mean $\pm$ SD. BMI is presented in kg/m^2 and FM, FFM, and PBF are presented in kg.

Data synthesis: The preferred reporting items for systematic reviews and meta-analysis (PRISMA) was followed (**Figure 1**).



Findings

The anthropometry and body composition characteristics of the geriatric population beyond and among the Asian Indians have been represented in Tables 1 and 2, respectively. Overall, the highest BMI was reported as 28.7 ± 5.0 in Mexico and the lowest as 20.3 ± 3.2 in Kolkata (Rangel, *et al.*, 2018; LÓpez-Ortega, *et al.*, 2015); the highest WHR was reported as 0.99 ± 0.9 from Mexico and lowest as 0.82 ± 0.06 from Mexico (LÓpez-Ortega, *et al.*, 2015; Baumgartner, 2000); highest PBF was reported as 43.4 ± 4.0 from New Mexico and lowest as 22.5 ± 2.7 from France (Baumgartner, 2000; Bonnefoy, *et al.*, 2002); highest FM was reported as 30.3 from Sweden and lowest as 21.7 ± 7.1 from Sweden, (Carlsson, *et al.*, 2009; Dey, *et al.*, 2003) and highest FFM was reported as 51.1 ± 6.6 from Mexico and lowest as 34.5 from Sweden (Rangel *et al.*, 2018; Carlsson, *et al.*, 2009).

Table 1
Anthropometry and Body Composition in Global Geriatric Population

<i>Authors</i>	<i>Year</i>	<i>Area</i>	<i>Nature of the study</i>	<i>Sample size</i>	<i>Findings</i>
Mateo <i>et al.</i>	2018	Northwest and central Mexico	Cross-sectional	430 individuals of ≥ 60 years age	Mean BMI, FM and FFM are higher among the population of northwest Mexico than those of the central BMI and FM are higher in females and FFM is higher in males of both regions.
López-Ortega <i>et al.</i>	2016	Mexico	Cross-sectional Population-based	7865 individuals aged 60-114 years; 3626 males and 4239 females	BMI = 28.7 ± 5.6 . BMI increased with age with statistically significant sex difference.
Gavrilidou <i>et al.</i>	2015	Sweden	Population-based Cross-sectional	3360 subjects of 60-99 years	BMI and WHR are higher in males than females. Higher BMI among the individuals with MI, stroke and CHF and males with instrumental daily activities and personal daily activities than controls. Lower BMI among the individuals with dementia and females with instrumental daily activities and personal daily activities than controls. Higher WHR among the individuals with dementia, males with instrumental daily activities, and stroke and females with personal daily activities than controls.

Lopez <i>et al.</i>	2011	Spain	Cross-sectional	456 individuals of 54-75 years; 169 males and 287 females	Lower WHR among the individuals with MI, CHF and females with stroke and cognitive impairment than controls. BMI and PBF are higher in females than males. Females are twice more prone to diseases and type 2 obesity.
Lim <i>et al.</i>	2011	Korea	Community-based Cross-sectional	565 individuals of >65 years; 287 males and 278 females	Higher BMI among the females than males. BMI and FM are higher among the MS affected individuals than the controls.
Setiati <i>et al.</i>	2010	Indonesia	Hospital-based Cross-sectional	702 individuals of ≥60 years age	More males were underweight than females (11.23% vs 9.86%) while overweight (21.74% vs 23%) and obesity (19.57% vs 23.71%) was higher in females.
Carlsson <i>et al.</i>	2008	Sweden	Randomized control intervention	191 individuals of 65-99 years	BMI, FM and FFM are higher in females than males.
Albala <i>et al.</i>	2007	Chile	Cross-sectional	377 individuals of ≥65 years age; 139 males and 238 females	Strong association of BMI with FM ($r=0.87$ in males and 0.91 in females).
García-Peña <i>et al.</i>	2007	Mexico	Cross-sectional	1968 individuals of ≥60 years; 1098 males and 870 females	Higher BMI and lower WHR among the females than males. BMI decreased and WHR increased with increasing age.

Barbosa <i>et al.</i>	2005	Brazil	Epidemiological Cross-sectional Population- based	1984 individuals of ≥ 60 years	BMI decreased with increasing age. Higher BMI among the females than males.
Albala <i>et al.</i>	2004	Santiago, Chile	Population- based Cross-sectional	1220 individuals of 60-99 years; 411 males and 819 females	Higher BMI among the females than males. BMI declined with age.
Gillete- Guyonnet <i>et al.</i>	2003	France	Cross-sectional	7518 females of >75 years	BMI, FM and FFM decreased and WHR increased with age.
Dey <i>et al.</i>	2003	Sweden	Cross-sectional	823 individuals of 70 and 75 years age	FFM is higher in males and PBF and FM are higher in females. FFM, FM and PBF declined with age.
Zamboni <i>et al.</i>	2002	Italy	Cross-sectional	275 individuals of 68-75 years; 95 males and 175 females	Significantly higher FFM and lower FM and PBF among the males than females.
Bonnefoy <i>et al.</i>	2002	France	Hospital-based Cross-sectional	911 individuals; 238 males and 673 females	Higher BMI and PBF and lower FFM among the males than females.

Perissinotto <i>et al.</i>	2002	Italy	Cross-sectional	3356 individuals of 65-84 years age	Significantly higher BMI among females and higher WHR among males. BMI and WHR decreased with increasing age. Both the underweight and obesity was higher in females than males.
Baumgartner <i>et al.</i>	2000	New Mexico	Population- based Cross-sectional	831 individuals of ≥ 60 years age	<i>Sarcopenic and non-sarcopenic non-obese group:</i> Higher BMI and WHR among the males and higher PBF among the females. <i>Sarcopenic and Non-Sarcopenic obese:</i> Higher BMI and PBF and lower WHR among the females than males.

All anthropometric values are shown in mean and $\pm$ SD. BMI is presented in kg/m^2 ; FM, FFM and PBF are presented in kg.

Table 2
Anthropometry and Body Composition in Asian Indian Population

<i>Authors</i>	<i>Year</i>	<i>Area</i>	<i>Nature of the study</i>	<i>Sample size</i>	<i>Findings</i>
Das et al.	2018	Haryana, India	Cross-sectional	206 females of ≥ 60 years age	12.1% individuals were underweight, 23.8% were overweight and 17% were obese.
Das et al.	2017	Haryana, India	Cross-sectional	206 females of ≥ 60 years age	4.87fold and 2.37fold risk of hypertension among the overweighted and normal-weighted females. <i>Normotensive group:</i> 13.8% underweight, 25.5% overweight and 20.7% obese. 67.6% had higher WHR. <i>Hypertensive group:</i> 8.2% underweight, 26.2% overweight and 49.2% obese. 85.2% had higher WHR. Significantly higher BMI and WHR among the hypertensive females than normotensive.
Ghosh et al.	2004	Kolkata, India	Cross-sectional	332 individuals of ≥ 60 years; 171 males and 161 females	Significantly higher BMI and FFM among the males than the females. Significantly higher PBF and FM among the females than males.

Ghosh et al.	2000	Kolkata, India	Cross-sectional	210 individuals of ≥ 55 years	Significantly higher BMI, WHR and FFM among the hypertensive individuals than the normotensive. PBF and FM were lower among the hypertensive individuals than the normotensive.
Tyagi et al.	2005	Delhi, India	Cross-sectional	279 females of 51-89 years	BMI (26.8 ± 5.1 to 23.2 ± 6.9) decreased and WHR (0.83 ± 0.0 to 0.87 ± 0.1) increased with age i.e. from 51-55 to 86+ years.

All anthropometric values are shown in mean and $\pm$ SD. BMI is presented in kg/m^2 ; FM, FFM and PBF are presented in kg.

Ethnic variation:

Anthropometric attribute: Among the non-Asian Indians, the highest BMI was reported as 28.7 ± 5.0 in Mexico and the lowest as 20.5 ± 2.1 from New Mexico (Baumgartner, 2000). Among the Asian Indians, the highest BMI was reported as 26.9 ± 5.9 from Haryana and the lowest as 22.54 ± 3.26 from Indonesia (Das, *et al.*, 2017; Setiati, *et al.*, 2010).

Central obesity: Among the non-Asian Indians, the highest WHR was reported as 0.99 ± 0.9 in Mexico and the lowest as 0.82 ± 0.06 in Mexico (López-Ortega, *et al.*, 2015; Baumgartner, 2000). Among the Asian Indians, the highest WHR was reported as 0.95 ± 0.05 in Kolkata and the lowest as 0.83 in Delhi (Ghosh, *et al.*, 2000; Tyagi, *et al.*, 2005).

Body composition: Among the non-Asian Indians, the highest PBF was reported as 43.4 ± 4.0 in New Mexico and the lowest as 22.5 ± 2.7 in France (Baumgartner, 2000; Bonnefoy, *et al.*, 2002); the highest FM was reported as 30.3 from Sweden and lowest as 21.7 ± 7.1 from Sweden (Carlsson, *et al.*, 2009; Dey, *et al.*, 2003), and highest FFM was reported as 51.1 ± 6.6 from Mexico and lowest as 34.5 from Sweden (Rangel, *et al.*, 2018; Carlsson, *et al.*, 2009).

Sex variation:

Anthropometric attribute: Among the non-Asian Indians, BMI ranged between 21.5 ± 1.9 and 28.19 ± 3.51 among males (Arroyo, *et al.*, 2007; Bonnefoy, *et al.*, 2002) and 20.5 ± 2.1 and 28.7 ± 5.6 among females (Baumgartner, 2000; López-Ortega, *et al.*, 2015).

Central obesity: Among the non-Asian Indians, WHR ranged between 0.94 ± 0.05 and 0.98 ± 0.05 among males (Baumgartner, 2000), and 0.82 ± 0.06 and 0.94 ± 0.08 among females (Baumgartner, 2000; Perissinotto, *et al.*, 2002).

Body composition: Among the non-Asian Indians, PBF ranged between 22.5 ± 2.7 and 29.5 ± 5.8 among the males (Baumgartner,

2000; Dey, *et al.*, 2003), and 18.8 ± 4.93 and 38.20 ± 7.14 among the females (Bonney, *et al.*, 2002; López, *et al.*, 2011). FM ranged between 18.8 ± 4.7 and 29.9 among the males (Rangel, *et al.*, 2018; Carlsson, *et al.*, 2009), and 22.8 ± 7.2 and 30.4 among the females (Dey, *et al.*, 2003; Carlsson, *et al.*, 2009). FFM ranged between 32.3 and 58.5 ± 5.4 among the males (Carlsson, *et al.*, 2009; Dey, *et al.*, 2003), and 35.31 ± 4.39 and 52.7 ± 10 among the females (Zamboni, *et al.*, 2002; Bonney, *et al.*, 2002).

Among the Asian Indians, sex differentiation in anthropometric and body composition characteristics could not conclude as only a single study denoted sex differentiation (Ghosh, 2004).

Discussion

Geriatric individuals are associated with several disorders like sarcopenia, frailty, dementia, cognitive impairment, etc. which affect their overall physical and mental health. Biological ageing is a multidimensional process influenced by several extrinsic factors including dietary components, loss of appetite, changes in food preferences, and taste sensitivity in geriatric individuals leads to nutrient deficiency with several health effects. Deficit protein or essential amino acid consumption reduces the muscle mass and functional ability resulting in sarcopenia and frailty (Kaur, *et al.*, 2019).

Sarcopenia: The clinical definition of sarcopenia states it as a loss of skeletal muscles and their functions and strength. The progressive muscle loss is associated with simultaneous fat accumulation causing frailty or fragility. Consequently, the BMI decreases and FM increases leading to altered pharmacokinetics. Besides, sarcopenia is associated with reduced physical activity, hormonal level reduction, and afflicted mitochondrial and muscle stem cell activities (Santilli, *et al.*, 2014).

Frailty: Frailty is a clinical geriatric syndrome, characterized by deregulating physiological systems and reduced pliancy to pregnable stressors (Fedarko, 2011). Increased fat mass accumulation and

excess adiposity with advancing age expedite the frailty reducing the capacity for physical activity which further accelerates obesity (Porter, *et al.*, 2014).

Dementia: Dementia develops cognitive decline with reduced functional capacity. Besides its clinical symptoms like memory loss, behavioural and communication impairments, and thinking or judgmental disabilities several studies have documented the association of dementia with sarcopenic obesity (Duong, *et al.*, 2017; Hsu, *et al.*, 2014; Canon, *et al.*, 2011; Tolea, *et al.*, 2015). Low BMI and high WHR among individuals with dementia and cognitive impairment have been documented in a population-based study (Gavriilidou, *et al.*, 2015).

Cardiovascular diseases: Cardiovascular health is another cause of poor survival and mortality among the geriatric population. As the biological ageing process is featured in the accumulation of FM and augmentation of PBF, the risk is higher among aged individuals, especially among females (López, *et al.*, 2011). Individuals with higher BMI, WHR, FM, and PBF have been reported with MI, CHF, and MS (Gavriilidou, *et al.*, 2015; Kang, *et al.*, 2011). Again, hypertensive individuals tend to have higher BMI, WHR, and FFM and lower PBF and FM (Ghosh, *et al.*, 2000). A South Asian study reported a positive association of several chronic diseases like T2DM, hypertension, and heart disease with BMI; WHR linearly increased with T2DM and hypertension and heart diseases and FM with the presence of heart diseases (Sood, 2016). Adequate consumption of folate and vitamin B6 has been demonstrated as a protecting factor for cardiovascular morbidity and mortality as it inhibits hyperhomocysteinemia (Ward, 2001).

Diabetes and insulin resistance: Increased susceptibility to T2DM and insulin resistance has been demonstrated as a key factor for developing sarcopenia (McManus, *et al.*, 1992). The underlying mechanism of insulin resistance is influenced by elevated free fatty acid and carbohydrate metabolism as evident in obese and diabetic individuals (Corrêa, *et al.*, 2020). Several studies have documented

lifestyle intervention with increased physical activity to delay the onset of insulin sensitivity and glucose intolerance along with the decline of FM and BMI (O'Leary, *et al.*, 2006; Solomon, *et al.*, 2008).

Thyroidism: Thyroid hormonal dysregulation is common among geriatric individuals due to elevated fibrosis and atrophy of the thyroid glands. Subclinical hypothyroidism is correlated with higher BMI and is considered a risk factor for overweight and obesity (Sanyal, *et al.*, 2016). A clinical, case-control study documented a parallel increase of thyroid stimulating hormone and free triiodothyronine with excess fat gain, BMI, and WHR. The study also accentuated nutrient intake to preclude this condition (Chomard, *et al.*, 1995).

Sex hormone: The estrogen deficiency incepting menopausal women diminishes the osmotic capacity of calcium in the intestine and kidney and inflates the parathyroid hormone concentration (Kaur, *et al.*, 2019). A dramatic increase in urinary excretion of gonadotrophins in males after 60 years onsets from 40 years of age. The metabolic clearance rate of the sex steroids decreases in old age and the testosterone converts into estradiol in males (Baker, *et al.*, 1976). Old age-associated decrease in sex hormone concentrations may instigate the serum leptin concentration. As the leptin level is higher among females, the age-related fat accumulation alters the hormone level more deliberately among them than in males (Baumgartner, 1999). The neuroendocrine mechanism of leptin produced by the adipocytes controls food consumption and energy expenditure; thus hyperleptinemia is a significant risk factor for obesity (de Luis, *et al.*, 2009).

Malnutrition: The lethal impact of malnutrition on geriatric health is more pronounced than in other populations. Malnutrition may be influenced by several environmental factors, ethnic predisposition, or hormonal alternations. The present review has documented multiple studies reporting 2.9 per cent to 60.2 per cent of geriatric individuals as malnourished, 31.9 per cent to 42 per cent of individuals at risk of malnutrition (Davidson and Getz, 2004; Silverman, *et al.*, 2014), and 26 per cent to 43 per cent individuals suffering from severe to

mild protein-energy malnutrition (Persson, *et al.*, 2002). The overall prevalence of undernutrition is higher in males and overnutrition in females (Sood, 2016; Setiati, *et al.*, 2012).

Vitamin D deficiency: Circumscribed movements due to osteoporotic fractures and reduced bone mineral density commonly observed among geriatric individuals are caused due to calcium and vitamin D deficiency (Kaur, *et al.*, 2019). Age-associated changes in metabolism minimize the supply of 25(OH)D leading to 1,25(OH)2D deficiency (Gallagher, 2013). 1,25(OH)2D is crucial for optimal homeostasis of several minerals essential for normal physiological functions. Spanish literature has documented significantly lower 25(OH)D concentration among morbidly obese females (Vilarrasa, *et al.*, 2007). A similar association between BMI and 25(OH)D has been found in an Italian study (Zamboni, *et al.*, 2002). Several researchers to date attempted to explore the underlying cause of 25(OH)D deficiencies in obese individuals but no specific mechanism is yet explored. A cohort study among Caucasian geriatric females explored that vitamin D deficiency is not due to a lack of sun exposure but due to a lack of food resources (Macdonald, *et al.*, 2011). Thus, a balanced diet may be beneficial to maintaining the optimal level of all essential nutrients and normal body weight.

Mineral deficiency: Vitamin deficiency among the geriatric population may arise due to elevated zinc concentration. An optimal zinc level is a prerequisite for strong immunity, enzyme catabolism, DNA synthesis, etc. Zinc regulates the production and absorption of retinol, tocopherol, and folate in the body. Deficiency in $C_8H_{11}NO_3$, cyanocobalamin, and folate increases the homocysteine level which ameliorates the susceptibility to depressive symptoms. (Kaur, *et al.*, 2019).

Physical activity: Regular exercise or voluntary physical activity fosters physical fitness, fat oxidation, and metabolism which reinforces immunity against chronic stress and inflammatory diseases by optimizing neuroplasticity and growth factor expression (Stange,

et al., 2013). Daily instrumental activities may increase the BMI and WHR among males more than those with voluntary physical activity as evident in studies (Gavriilidou, *et al.*, 2015).

Conclusion

A Larger section of the literature has documented higher BMI, PBF, and FM among females than males. On the other hand, all of the works of literature have reported higher WHR and FFM among males.

BMI in both sexes is found to decline with age; a tendency towards overweight among individuals of <60 years of age was noted which further declined towards the normal range with senescence. Prevalence of overweight was higher among the females. WHR increased with age indicating abdominal obesity with special notation among the males. PBF and FM were higher among females while FFM is higher among males. PBF and FM were found to simultaneously increase with age indicating obesity-associated disorder.

Prevalence of overweight is higher among non-Asian Indians; central obesity is predominant in both non-Asian Indians and Asian Indians. Fat mass is higher among the Asian Indian population.

Regular follow-up of any hormonal changes, or morbid conditions whether nutritional, psychological, cardiovascular, or cardio-metabolic, bears crucial importance for assessment and improvement of overall geriatric health.

Limitations

- i. The scarcity of literature is widely observed among the geriatric population from both developed and developing countries.
- ii. No literature of African origin could be found in the last two decades.
- iii. Compared to the BMI and WHR, information on the body composition variables is scarce.
- iv. Information on the over 80 population is notably meagre.

- v. Most of the studies did not work on the representative population of their community or country. A small sample size may not yield the real scenario of the health status.
- vi. Most of the studies are clinical and hospital-based hence, morbid conditions may have an impact on the outcomes. Population-based studies are essentially required to comprehend the present health condition of the geriatric population.
- vii. The majority of studies are cross-sectional. Works of literature showing the age-group variation have documented declining health status with advancing age. Thus, longitudinal studies may more effectively explore the biological ageing process among the geriatric population.
- viii. Ethnicity is a crucial factor playing role in public health condition however, literature showing the ethnic variation of anthropometry and body composition characteristics are insufficient in the present review.
- ix. Few studies denoted the association of diet, smoking habits, and physical activity with the anthropometry and body composition characteristics of the geriatric population. No studies represented extensive research outcomes focusing on the overall lifestyle and behavioural factors and their impact on geriatric health.
- x. Information on the genetic mechanism underlying geriatric health is scarce thus future studies focusing on this area may provide crucial information in geriatric health research.
- xi. Many papers have documented the percentile values of anthropometric and body composition measures however, a universal and/or community-specific cut-off value is essentially required for future geriatric health research.

References

- Arroyo, P., Lera, L., Sánchez, H., Bunout, D., Santos, JL., Albala, C., (2007): Anthropometric indicators, body composition and functional limitations in the elderly. *Rev méd Chile*, 135:846-54.

- Baker, HWG., Burger, HG., de Krester, DM., Hudson, B., O'Connor, S., Wang, C., Mirovics, A., Court, J., Dunlop, M., Rennie, GC., (1976): Changes in the pituitary-testicular system with age. *Clin Endocrinol*, 5:349-72.
- Barbosa, AR., Souza, JMP., Lebrão, ML., Laurenti, R., Marucci, Maria de FN., (2005): Anthropometry of elderly residents in the city of São Paulo, Brazil. *Cad Saúde Pública*, 21:1929–38.
- Baumgartner, RN., Waters, DL., Morley, JE., Patrick, P., Montoya, GD., Garry, PJ., (1999): Age-related changes in sex hormones affect the sex difference in serum leptin independently of changes in body fat. *Metabolism*, 48:378–84.
- Baumgartner, RN. (2000): Body composition in healthy aging. *Ann N Y Acad Sci.*, 2000;437-48.
- Bonnefoy, M., Jauffret, M., Kostka, T., Jusot, JF. (2002): Usefulness of Calf Circumference Measurement in Assessing the Nutritional State of Hospitalized Elderly People. *Gerontol.*, 48:162–9.
- Carlsson, M., Gustafson, Y., Eriksson, S., Håglin, L. (2009): Body composition in Swedish old people aged 65–99 years, living in residential care facilities. *Arch Gerontol Geriatr.*, 49:98–107.
- Canon, ME., Crimmins, EM., (2011) Sex differences in the association between muscle quality, inflammatory markers, and cognitive decline. *J Nutr Health Aging*, 695–8.
- Chomard, P., Vernhes, G., Autissier, N., Debry, G., (1985): Serum concentrations of total T4, T3, reverse T3 and free T4 T3 in moderately obese patients. *Hum Nutr.*, 39:371-78.
- Corrêa, TAF., Rogero, MM., (2020): Diabetes, microRNA, and Nutrition in Geriatrics. *Curr Geri Rep.*, 9:229–36.
- Das, S., Chandel, S. (2018): Frailty pattern among the elderly rural women in India. *Int J Gerontol*, 32:138-148.
- Das, S., Chandel, S. (2017): Association between blood pressure and anthropometric indicators of obesity among elderly rural women in India. *IJHW*, 8:950-53.

- Davidson, J., Getz, M., (2004): Nutritional Risk and Body Composition in Free-Living Elderly Participating in Congregate Meal-Site Programs. *J Nutr Elder*, 24:53–68.
- De Luis, DA., Castrillón, JLP., Dueñas, A., (2009): Leptin and obesity. *Minerva Med.*, 100:229-36.
- Dey, DK., Bosaeus, I., Lissner, L., Steen, B. (2003): Body composition estimated by bioelectrical impedance in the Swedish elderly. Development of population-based prediction equation and reference values of fat-free mass and body fat for 70- and 75-y olds. *Eur J Clin Nutr.*, 57:909–16.
- Duong, S., Patel, T., Chang, F., (2017): Dementia: What pharmacists need to know. *Can Pharm J (Ott)*, 150:118–29.
- Gavrilidou, NN., Pihlsgård, M., Elmståhl, S., (2015) Anthropometric reference data for elderly Swedes and its disease-related pattern. *Eur J Clin Nutr.*, 69:1066–75.
- Gallagher, JC., Yalamanchili, V., Smith, LM., (2013): The Effect Of Vitamin D Supplementation On Serum 25OHD In Thin And Obese Women. *J Steroid Biochem Mol Biol.*, 136:195–200.
- Ghosh, A., Bose K, Das Chaudhuri AB., (2000): Comparison of anthropometric characteristics between normotensive and hypertensive individuals among a population of Bengalee Hindu elderly men in Calcutta, India. *J R Soc Promot Health.*, 120:100–6.
- Ghosh, A., (2004): Age and sex variation in measures of body composition among the elderly Bangalee Hindus of Calcutta, India. *Coll. Antropol.*, 2:553-61.
- Gillette-Guyonnet, S. (2003): Body composition in French women 75+ years of age: The EPIDOS study. *Mech Ageing Dev.*, 124:311–6.
- Hsu Y-H, Liang C-K, Chou M-Y, Liao M-C, Lin Y-T, Chen L-K, et al (2014): Association of cognitive impairment, depressive symptoms and sarcopenia among healthy older men in the veterans retirement community in southern Taiwan: A cross-sectional study. *Geriatr Gerontol Int*, 14:102–8.

- Kang, SM., Yoon, JW., Ahn, HY., Kim, SY., Lee, KH., Shin H., *et al* (2011): Android Fat Depot Is More Closely Associated with Metabolic Syndrome than Abdominal Visceral Fat in Elderly People. *PLoS ONE*, 6:e27694.
- Kaur, D., Rasane, P., Singh, J., Kaur, S., Kumar, V., Mahato, DK., *et al* (2019): Nutritional Interventions for Elderly and Considerations for the Development of Geriatric Foods. *CAS*, 12:15–27.
- López, PM., Fernández-Ballesteros, R., Zamarrón, MD., López, SR. (2011): Anthropometric, body composition and health determinants of active ageing: A gender approach. *J Biosoc Sci*, 43:597–610.
- López-Ortega, M., and Arroyo, P. (2015): Anthropometric characteristics and body composition in Mexican older adults: Age and sex differences. *Brit J Nutr*, 115:490-499.
- Macdonald, HM., Mavroeidi, A., Aucott, LA., Diffey, BL., Fraser, WD., Ormerod, AD., Reid, David M. (2011): Skin Color Change in Caucasian Postmenopausal Women Predicts Summer-Winter Change in 25-Hydroxyvitamin D: Findings from the ANSAViD Cohort Study. *J Clin Endocrinol Metab*, 96:1677–86.
- McManus, RM., Ryan, EA., (1992): Insulin requirements in insulin-dependent and insulin-requiring GDM women during final month of pregnancy. *Diabetes Care*, 15:1323–7.
- O’Leary, VB., Marchetti, CM., Krishnan, RK., Stetzer, BP., Gonzalez, F., Kirwan, JP., (2006): Exercise-induced reversal of insulin resistance in obese elderly is associated with reduced visceral fat. *J Appl Physiol*, 100:6.
- Persson, MD., Brismar, KE., Katzarski, KS., Nordenstrom, J., Cederholm, TE.,(2002): Nutritional Status Using Mini Nutritional Assessment and Subjective Global Assessment Predict Mortality in Geriatric Patients. *J Am Geriatr Soc*, 50:1996–2002.

- Perissinotto, E., Pisentm, C., Sergi, G., Grigoletto, F., Enzi, G., ILSA Working Group (2002): Anthropometric measurements in the elderly: age and gender differences. *Br J Nutr*, 87:177–86.
- Porter Starr, KN., McDonald, SR., Bales, CW.(2014); Obesity and Physical Frailty in Older Adults: A Scoping Review of Intervention Trials. *J Am Med Dir Assoc.*, 15:240–50.
- Ravaglia, G., Morini, P., Forti, P., Maioli, F., Boschi, F., Bernardi, M., Gasbarrini, G. (1997): Anthropometric characteristics of healthy Italian nonagenarians and centenarians. *Brit J Nutr.*, 77:9–17.
- Rangel Peniche, DB., Alemán Mateo, H., Barreiro Ma de los, AA., Ruiz Valenzuela, RE., Ramírez-Torres, M., Urquidez-Romero, R., (2018): Differences in Body Composition in Older People from Two Regions of Mexico: Implications for Diagnoses of Sarcopenia and Sarcopenic Obesity. *Biomed Res Int*.
- Santilli, V., Bernetti, A., Mangone, M., Paoloni, M. (2014): Clinical definition of sarcopenia. *Clin Cases Miner Bone Metab.*, 11:177–80.
- Santos, JL., Albala, C., Lera, L., García, C., Arroyo, P., Pérez-Bravo, F., Angel, B., Peláez, M., (2004): Anthropometric measurements in the elderly population of Santiago, Chile. *Nutrition*, 20:452–7.
- Sanyal, D., Raychaudhuri, M., (2016): Hypothyroidism and obesity: An intriguing link. *Indian J Endocrinol Metab.*, 20:554–7.
- Setiati, S., Istanti, R., Andayani, R., Kuswardhani, RAT., Aryana, IS., Putu, ID., Apandi, M., Ichwani, J., Soewoto, S., Dinda, R., Mustika, S., (2010): Cut-off of Anthropometry Measurement and Nutritional Status Among Elderly Outpatient in Indonesia: Multi-centre Study. *Acta Med Indones*, 42:7.
- Silverman, MN., Deuster, PA., (2014): Biological mechanisms underlying the role of physical fitness in health and resilience. *Interface Focus*, 4.

- Solomon, TPJ., Sistrun, SN., Krishnan, RK., Del Aguila LF, Marchetti, CM., O'Carroll, SM., O'Leary, VP., Kirwan,JP., (2008): Exercise and diet enhance fat oxidation and reduce insulin resistance in older obese adults. *J Appl Physiol*, 104:1313–9.
- Sood, S.,(2016): Studies on the Correlation of Anthropometric Measurements with Health Outcomes in Elderly. *AOWMC*, 5.
- Stange, I., Poeschl, K., Stehle, P., Sieber, CC., Volkert, D., (2013): Screening for malnutrition in nursing home residents: Comparison of different risk markers and their association to functional impairment. *J Nutr Health Aging*, 17:357–63.
- Tolea, MI., Galvin, JE., (2015) Sarcopenia and impairment in cognitive and physical performance. *Clin Interv Aging*, 10:663–71.
- Tyagi, R., Kapoor, S., Kapoor, AK.,(2005): Body composition and fat distribution pattern of urban elderly females, Delhi, India. *Coll. Anthropol.*, 2:493-8.
- Vilarrasa, N., Maravall, J., Estepa, A., Sánchez, R., Masdevall, C., Navarro, MA., Alía,P., Soler,J., Gómez,JM., (2007): Low 25-hydroxyvitamin D concentrations in obese women: Their clinical significance and relationship with anthropometric and body composition variables. *J Endocrinol Invest.*, 30:653–8.
- Ward, M.,(2001): Homocysteine, folate, and cardiovascular disease. *Int J Vitam Nutr Res*, 71:173-8.
- Zamboni, M., Zoico, E., Tosoni, P., Zivelonghi, A., Bortolani, A., Maggi, S., Francesco, VD.,Bosello,O., (2002): Relation Between Vitamin D, Physical Performance, and Disability in Elderly Persons. *J Gerontol BiolSci Med Sci.*, 57:M7–11.

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Sentence Repetition Skill in Kannada Speaking Healthy Adults

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ABSTRACT

The present study was an attempt to understand sentence repetition patterns in 120 healthy adults, (Males and females in equal numbers) ages varying from 35 to 55 years with Kannada as their first language. As a tool for the study, compound sentences under 10 categories, namely, assertive, interrogative, imperative, exclamatory, direct, indirect, causatives, active voice, conditional, and relative clauses imitation, were selected. Each category consisted of two sentences forming a total of 20 sentences. All the sentences were recorded by a female Kannada speaker using Adobe audition software (version 2.4.2). The participants were asked to listen to each pre-recorded sentence and repeat it as close to the original stimulus. The responses were audio recorded using a digital voice recorder with a high-quality 50 built-in microphone. The response was analyzed for correct sentence repetition and error type. Sentence repetition scores and word correct scores in sentence repetition tasks decreased with age. No effect of gender was noted on

the sentence repetition tasks. The results also indicate that the substitution errors' frequency was higher, followed by omission, addition, transposition, and code-mixing. Age-related cognitive differences and language differences might have resulted in a decline in the performance of sentence repetition tasks.

Keywords: Healthy adults, Kannada, Compound sentence, Sentence repetition, Age-related changes,

Sentences are a group of words that can stand alone for expressing complete thoughts. Sentences vary in terms of length and complexity (Marinis, and Armon-Lotem, 2015). As the length and complexity of sentences increase, the sentences cannot be simply copied. Hence, the individuals resort to the grammatical system to be able to repeat the sentences by processing, analyzing, and reconstructing their meaning. Sentence repetition tasks tap into the linguistic knowledge underlying the processes of language comprehension and production. For comprehension, sentence repetition requires participants to process a heard sentence, decode it and reconstruct its meaning. Concerning production, the repetition of the sentence involves lexical retrieval, grammatical encoding, and phonological realization (Klem, *et al.*, 2015).

Sentence repetition tasks have been used for many years as a useful tool that helps to analyse language skills and identify individual differences in language ability. The diagnostic validity of sentence repetition tasks has been confirmed by many researchers across various age ranges (Conti-Ramsden, *et al.*, 2001; Poll, *et al.*, 2010), languages (Stokes, *et al.*, 2006; Vang Christensen, and Hansson, 2012), and disability categories (Redmond, 2005; Taylor, 2014). There has been wide use of sentence repetition tasks clinically for identifying adults with language difficulties, aphasia (Meyers, *et al.*, 2000), brain injury (Ibid), Alzheimer's Disease (Small, 2000), dementia, and developmental language impairment (Hammill, and Newcomer, 1997; Semel, 2004)

Sentence repetition in different languages can indicate a variety of linguistic and language-related skills (Seeff-Gabriel, *et al.*, 2010). Sentence repetition tasks are widely used clinically and have been considered useful because of their sensitivity to residual language processing weaknesses which may not be detected on other expressive and receptive language tasks (Stothard, 1998; Conti-Ramsden, *et al.*, 2001). However, the underlying abilities such as syntactic complexity, length, and frequency of words in sentence repetition measured are poorly understood in healthy adults. Assessing sentence repetition skills in healthy individuals with matured language systems for various grammatical forms helps in understanding the influence of sentence type on repetition tasks. This type of assessment will serve as a clinical tool for the assessment and management of adult language disorder cases. Hence, the present study was taken with the following aim and objectives.

Objectives of the study

1. To investigate the performance of Kannada-speaking healthy adults across the four age groups (35-40; 41-45; 46-50; & 51-55 years) on immediate verbal sentence repetition task.
2. To investigate the error types in sentence repetition tasks in Kannada-speaking healthy adults across the four age groups (35-40; 41-45; 46-50; & 51-55 years).
3. To study gender differences, if any.

Method

Sample

120 healthy adults, ages ranging from 35 to 55 years, and having a high level of proficiency (L1) in the Kannada language, were selected in this cross-sectional and normative study.

Written consent was obtained from the participants by informing them about the study and the clinical relevance of their participation in this study. As the first step, demographic information, age, gender, and educational qualification of participants were documented. The language proficiency of the participants was assessed using the "Language experience and proficiency questionnaire – India" which is a viable tool in assessing the language proficiency of an individual and

the factors contributing to it (Maitreyee, and Goswami, 2009). This questionnaire will help the professionals to find out the level of proficiency of an individual in a language on four basic skills, i.e., understanding, speaking, reading, and writing. The cognitive and language ability of the participants was assessed through a Mini-mental state examination (Folstein, *et al.*, 1975). The Mini-Mental State Exam (MMSE) is a widely used test of cognitive function among adults; it includes tests of orientation, attention, memory, language, and visual-spatial skills. Participants were screened for hearing ability using the “Hearing Test” which is a pure tone screening application at 500, 1000, 2000, and 4000 Hz. The subjects were assessed for any ear infections, tinnitus, and giddiness. Participants who passed the screening tests were included in this study.

Exclusion criteria for selection of participants

Participants with a history of speech-language problems, hearing loss, seizures, and other neurological disorders, and prior enrolment in speech or language intervention were excluded. This information was obtained through an informal interview with the participants.

The participants were divided cross-sectionally into four subgroups. Each group had five years of age intervals, viz G1: 35-40, G2: 41-45, G3: 46-50, and G4: 51-55 years. Each subgroup consisted of 30 participants having equal numbers of males and females.

Procedure

The three main types of sentences were: simple, compound, and complex sentences. A simple sentence is a sentence having a single independent clause with no dependent clauses. A sentence having two or more independent clauses but no dependent clauses are called a compound sentence. A sentence consisting of a single independent clause and one or more dependent clauses is called a complex sentence (Lester and Beason, 2019). In the present study compound sentence under the categories: assertive, interrogative, imperative, exclamatory, direct, indirect, causatives, active voice, conditional, and relative clauses imitation were selected. Each category consisted of two sentences forming a total of 20 sentences.

Stimulus recording

The test stimulus was recorded in a sound-treated room with low ambient noise as per ANSI guidelines. The recording was done by a female Kannada speaker with good proficiency in speaking, reading, and writing the Kannada language. The stimulus recording was carried out using Adobe audition software (version 2.4.2) attached with a dynamic microphone with a 10 cm distance between the microphone and the speaker. A 10 seconds gap was given after recording each sentence to avoid overlap between sentences. Adobe audition software (version 2.4.2) was used in this study for ensuring a better quality of voice and noise reduction. The Adobe audition is a comprehensive toolset that includes multitrack, waveform, and spectral display for creating, mixing, editing, and restoring audio content developed by Adobe Inc. The audio-recorded stimulus was given to three speech-language pathologists to check for intelligibility, quality of the recording, and prosodic features. Based on the feedback from the judges' suitable modifications were made to the recording.

The test of sentence repetition was administered in a noise-free environment. The participants were made to sit comfortably and were presented with recorded Kannada sentence samples. The participants were presented with instructions. "I will play the audio-recorded Kannada sentences. Listen to each sentence carefully and repeat the sentence back exactly as it is heard." The participants' responses were audio recorded using a portable digital audio recorder with a high-quality built-in microphone. No time limit was provided for the repetition of the sentences. On request by the participants, the recorded stimulus was represented by the examiner. When needed, breaks were also given in between recordings. During the time of recording cues and corrections were not given to the participants.

Analysis and coding

The responses obtained were analysed in the following manner:

1. Performance on overall sentence repetition was scored in a binary fashion, where (1) a score of one was provided if the sentence

was grammatically correct and (2) a score of zero was given if the sentence was grammatically incorrect. Words correctly repeated in a sentence were scored as follows: (1) correct repetition of each word was given a score of one and (2) word omission and word substitution were scored as zero.

2. Error analysis: The errors considered in this study include (1) addition - extra words added to a sentence, (2) omission - words missed out from a sentence, (3) substitution - word of similar or dissimilar meaning substituted to the target word, (4) code mixing - replacing a word with a similar meaning word of another language, (5) transposition - a word is repeated correctly but in a wrong position. The frequency of each type of error was calculated.

Results and Discussion

The scores obtained in the sentence repetition task were tabulated using the SPSS software. Using descriptive statistics, mean and standard deviation were obtained across the four subgroups in males and females separately for sentence repetition and correct word repetition. Mann Whitney U test was employed to obtain statistical significance across gender. An analysis of variance (ANOVA) was carried out using an alpha level of 0.05, to see the effect of the independent variable (groups: G1, G2, G3, and G4) on the dependent variable (compound sentences)

Table 1

Mean and SD for sentence repetition (compound sentences) and values across gender

<i>Age (years)</i>	<i>Compound sentence</i>					
	<i>Male Mean</i>	<i>SD</i>	<i>Female Mean</i>	<i>SD</i>	<i>Male Vs Female /Z/</i>	<i>Sig</i>
35-40	17.07	2.49	17.33	2.09	.83	NS
41-45	16.47	3.50	16.67	2.79	.87	NS
46-50	13.53	4.38	13.87	3.66	.83	NS
51-55	12.27	2.81	12.33	4.23	.80	NS

S: significant, NS: not significant

Above table 1 demonstrates the mean values for the sentence repetition test across the four subgroups. G1 had the highest and G4 had the lowest mean. The overall result from Table 1 reveals that as age increased the sentence repetition ability decreased. Mann – Whitney U test was employed for comparing the differences between sentence repetition values across gender. Results revealed that there was no statistical difference at a 0.05 level of significance across gender in all the four subgroups.

Table 2
One way ANOVA results for sentence repetition

<i>Group differences</i>		
<i>Groups</i>	<i>Mean difference</i>	<i>Sig</i>
G1 vs. G2	.63	.93
G1 vs. G3	3.50	.00
G1 vs. G4	4.90	.00
G2 vs. G3	2.86	.01
G2 vs. G4	4.26	.00
G3 vs. G4	1.40	.62

Table 2: ANOVA results suggest that sentence repetition scores of the groups differ significantly for compound sentences $F \{(3, 116) = 15.08\}$ $p < 0.05$. Mean differences were significant for G1 vs G3, G1 vs G4, G2 vs G3, and G3 vs G4 and not significant for G1 vs G2 and G3 vs G4 at 0.05 level of significance.

Table 3
Mean and SD for correct words repeated in sentence repetition task

<i>Age(years)</i>	<i>Compound sentence</i>					
	<i>Male</i>		<i>Female</i>		<i>males Females</i>	
	Mean	SD	Mean	SD	/Z/	Sig
35-40	123.47	4.24	122.33	3.41	.36	NS
41-45	121.20	5.67	121.73	4.80	.90	NS
46-50	116.20	9.23	117.87	6.72	.62	NS
51-55	112.60	6.63	114.07	7.94	.90	NS

S: significant, NS: not significant

Table 3 reveals that with an increase in age, there was a decrease in correct words repeated in the sentence repetition task. Mann – Whitney U test was conducted to compare the differences between Sentence repetition values for correct words repeated across gender. Results revealed that there was no statistical difference at a 0.05 level of significance between males and females across the four subgroups.

Table 4
One way ANOVA results for correct words repeated in sentence repetition task

<i>Groups</i>	<i>Group differences</i>	
	<i>Mean difference</i>	<i>Sig</i>
G1 vs. G2	1.43	.77
G1 vs. G3	5.86	.00
G1 vs. G4	9.56	.00
G2 vs. G3	4.43	.07
G2 vs. G4	8.13	.00
G3 vs. G4	3.70	.32

Table 4: ANOVA results suggest that scores for correct words repeated in a sentence repetition task of the groups differ significantly for compound sentences $F \{(3, 116) = 14.45\}$ $p < 0.05$. Mean differences were significant for G1 vs G3, G1 vs G4, and G3 vs G4 and not significant for G1 vs G2, G2 vs G3, and G3 vs G4.

Error analysis:

The errors considered in this study include (1) addition - extra words added to a sentence, (2) omission - words missed out from a sentence, (3) substitution – word of similar or dissimilar meaning substituted to the target word, (4) code mixing - replacing a word with a similar meaning word of another language, (5) transposition - a word is repeated correctly but in a wrong position. The frequency of each type of error was calculated and the percentage of errors was obtained

<i>Age group</i>	<i>Substitution</i>	<i>Omission</i>	<i>Addition</i>	<i>transposition</i>	<i>Code mixing</i>
35-40	64%	19%	16%	0%	1%
41-45	53%	31%	14%	1%	1%
46-50	50%	36%	8%	3%	3%
51-55	49%	37%	10%	2%	2%

Error analysis results revealed that the frequency of substitution errors was more for the sentence repetition test followed by Omission, addition, transposition, and code-mixing in all four groups. The percentage of occurrence of word substitution was greater in the 35–40 years age group. The percentage of occurrence of word omission was greater in the 41–45 years; 46–50 years; and 51–55 years age group.

Based on the findings of this study, it may be concluded that sentence repetition scores and word correct scores in sentence repetition tasks decreased with increasing age of Kannada-speaking healthy adults aged 35–55 years. No effect of gender was noted on sentence repetition tasks across all age groups. Sentence repetition is a cognitive task that involves semantic, grammatical, and syntactic processing, and not just a mechanical memorization task” (Ota, 2009). Research has shown that sentence repetition taps into the learners’ implicit knowledge (Ellis, 2005; Erlam, 2006), particularly the length of a sentence (Marinis, & Armon-Lotem, 2015). Although age-related cognitive differences are not extensive, there is a subtle decline in cognition during middle age. But the differences do not occur in the same magnitude and direction across individuals, cognitive domains, and tasks (Ferreira, 2017). Therefore, age-related cognitive differences and language differences might have resulted in a decline in the performance of sentence repetition with an increase in age as reported in our study. The results also indicate that the frequency of substitution errors was more, followed by omission, addition, transposition, and code-mixing. The substitutions seen in the sentence repetition task show that participants are not just parroting the sound they have heard and that it requires cognitive processes, including syntactic and semantic processes (Sunada, 2009).

The number of participants was insufficient in this study. Hence for the generalization of the results, large sample size is warranted.

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References

- Conti-Ramsden, G., Botting, N., and Faragher, B. (2001). Psycholinguistic markers for specific language impairment (SLI). *Journal of Child Psychology & Psychiatry & Allied Disciplines*, 42 (6), 741–748.
- Ellis, R. (2005). Measuring implicit and explicit knowledge of a second language: A psychometric study. *Studies in Second Language Acquisition*, 27, 141–172.
- Erlam, R. (2006). Elicited imitation as a measure of L2 implicit knowledge: An empirical validation study. *Applied Linguistics*, 27, 464–491.
- Ferreira, D., Machado, A., Molina, Y., Nieto, A., Correia, R., Westman, E., and Barroso, J. (2017). Cognitive Variability during Middle-Age: Possible Association with Neurodegeneration and Cognitive Reserve. *Frontiers in aging neuroscience*, 9, 188.
- Folstein, MF; Folstein, SE; McHugh, PR (1975). “Mini-mental status”. A practical method for grading the cognitive state of patients for the clinician”. *Journal of Psychiatric Research*. 12 (3): 189–98.
- Hammill, D. D., and Newcomer, P. L. (1997). *Test of Language Development–Intermediate*, Third Edition. Austin, TX: Pro-Ed
- Klem, M., Melby-Lervåg, M., Hagtvet, B., Lyster, S. A., Gustafsson, J. E., and Hulme, C. (2015). Sentence repetition is a measure of children’s language skills rather than working memory limitations. *Developmental science*, 18(1), 146–154.
- Maitreyee, R and Goswami, S. P. (2009). Language Proficiency Questionnaire: An Adaptation of LEAP-Q in Indian Context (Unpublished master’s thesis). All India Institute of Speech and Hearing, Mysore, India.

- Mark Lester and Larry Beason(2019): English Grammer and Usage, Third Edition, The McGrow-Hill Education, New Delhi
- Marinis, T., and Armon-Lotem, S. (2015). "Sentence repetition," in *Assessing Multilingual Children: Disentangling Bilingualism from Language Impairment*, (eds.) S. ArmonLotem, J. de Jong, and N. Meir; Bristol: Multilingual Matters, 95–122.
- Meyers, J. E., Volkert, K., and Diep, A. (2000). Sentence repetition test: updated norms and clinical utility. *Applied neuropsychology*, 7(3), 154–159.
- Ota, E. (2009). The role of sentence repetition in foreign language learning: sentence repetition processes by Japanese EFL learners. Unpublished doctoral dissertation, the United Graduate School of Education, Tokyo Gakugei University: Tokyo.
- Poll, G. H., Betz, S. K., and Miller, C. A. (2010). Identification of clinical markers of specific language impairment in adults. *Journal of Speech, Language, and Hearing Research*, 53, 414–429.
- Redmond S. M. (2005). Differentiating SLI from ADHD using children's sentence recall and production of past tense morphology. *Clin. Linguist. Phon.* 19, 109–127.
- Seeff-Gabriel, B., Chiat, S., and Dodd, B. (2010). Sentence imitation as a tool in identifying expressive morphosyntactic difficulties. *Int. J. Lang. Commun. Disord.* 45, 691–702.
- Semel, E., Wiig, E., and Secord, W. (2004). *Clinical Evaluation of Language Fundamentals – Preschool*, 2nd ed. San Antonio, TX: Pearson.
- Small, J. A., Kemper, S., and Lyons, K. (2000). Sentence repetition and processing resources in Alzheimer's disease. *Brain and language*, 75(2), 232–258.
- Stokes S. F., Wong A. M., Fletcher P., Leonard L. B. (2006). Non word repetition and sentence repetition as clinical markers of specific language impairment: the case of Cantonese. *J. Speech Hear. Res.* 49, 219–236.

- Stothard, S.E., Snowling, M.J., Bishop, D., Chipchase, B.B., & Kaplan, C.A. (1998). Language-impaired preschoolers: a follow-up into adolescence. *Journal of Speech, Language and Hearing Research*, 41 (2), 407–418.
- Sunada, M. (2009). Sentence Repetition as a Measure of Learners' English Proficiency. <http://hdl.handle.net/2309/136310>
- Taylor, L. J., Maybery, M. T., Grayndler, L., and Whitehouse, A. (2014). Evidence for distinct cognitive profiles in autism spectrum disorders and specific language impairment. *Journal of Autism and Developmental Disorders*, 44, 19–30.
- Vang Christensen, R., and Hansson, K. (2012). The use and productivity of past tense morphology in specific language impairment: An examination of Danish. *Journal of Speech, Language, and Hearing Research*, 55, 1671–1689.

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Determinants of Malnutrition of Elderly Living in Slum and Non-Slum Areas in Bangladesh during COVID-19

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ABSTRACT

The study aimed to assess the prevalence and determinants of malnutrition among 250 elderly persons living in slum (N=100; Males 59 and females 41) and non-slum (N=150; Males and females in equal numbers) areas during COVID-19 in Dhaka city of Bangladesh. These subjects were interviewed from August to October 2020. Mini Nutrition Assessment Short Form was also used in the data collection. Descriptive statistics, the Chisquare test, and the Logistic regression model were used for the analysis of data. The results show that most of the elderly were at risk of being malnourished. The slum elderly were more malnourished and were at risk of malnutrition than the non-slum elderly. The analysis reveals that age, occupation, and marital status are significantly associated with nutritional status. These findings may

be helpful for the policy makers to improve the nutritional condition of the elderly, especially in slum areas of the country.

Keywords: Ageing, Malnutrition, Family type, Occupation, Income

Developing countries are experiencing a growing number of aged populations (Khan, *et al.*, 2014) and Bangladesh is no exception to it. The growth rate of the elderly is higher than the growth rate of the total population. According to information provided by the Bangladesh Bureau of Statistics, around 7.5 percent of the country's total population constitutes elderly people while the number is expected to increase sharply and reach around 20 percent by 2050 (BBS, 2011).

Ageing is a complex process with changes in physiological, psychological, and social factors that may impact nutritional status. Malnutrition is a frequent syndrome in the elderly. It refers to inadequate nutritional status, undernourishment characterized by insufficient dietary intake, poor appetite, muscle wasting, and weight loss. It affects the quality of life of the elderly (Maseda, *et al.*, 2016). The nutritional status of the elderly population has become an important issue but often gets neglected. Both under-nutrition and overnutrition are important public health priorities in this vulnerable group. Malnutrition is higher as age increases, among females and individuals with no formal education. It is necessary to identify those with malnutrition and at risk of malnutrition among the elderly population and address healthy dietary practices (Krishnamoorthy, *et al.*, 2018). Research on public health activities in Bangladesh has emphasized largely nutritional aspects related to children and women of reproductive age (Pryer, *et al.*, 2003) but research on the nutrition of the elderly is scarce and not properly documented.

Since the growth rate of ageing in less developed nations is currently faster than the developed countries of the world, due attention should be given to elderly-oriented research in developing countries like Bangladesh. Nutrition is an important element of health in the elderly population and affects the aging process. In Bangladesh, a couple of

studies have been conducted on the nutrition of the elderly but very few studies focused on the elderly in slum and non-slum areas. The slum elderly are suffering more than the non-slum elderly due to a shortage of income and health facilities. The relationship between nutritional status, economic condition, and demographic factors of the elderly are still little-explored in Bangladesh, especially for those in slum and non-slum areas. Therefore, the objective of this study is to investigate the association of nutritional status of elderly living in slum and non-slum areas of Dhaka city in Bangladesh during COVID-19.

Materials and Methods

The data of the present empirical study was collected from 250 randomly selected elderly persons, ages varying from 60 years and above, living in both slums (N=100; Males 59 and females 41) and non-slum (N=150; Males and females in equal numbers), areas of Dhaka city in Bangladesh during August to October 2020. A structured questionnaire, along with Mini Nutrition Assessment (MNA) Short Form was administered for collecting the required information from the respondents.

The Mini nutritional assessment (MNA) tool is a well-validated tool for assessing malnutrition in the elderly. The tool was shown to have an accuracy of 92 per cent when it was compared with a clinical evaluation by two physician specialists in nutrition (Vellas, *et al.*, 2006).

Chisquare test, t-test, and Logistic regression model were applied for data analysis.

Results and Discussion

Table 1 shows the distribution of socio-economic and demographic characteristics of the Elderly. About 54 per cent elderly are male and 46 per cent are female. Most (48.4%) of the elderly belonged to 70 to 79 years old. About 40 per cent elderly are from slum areas and 60 per cent elderly are from the non-slum area. About 84 per cent elderly are Muslim and the rest belongs to other religion. Among them, about 97 per cent of respondents are Muslim in a slum area and 73.3 per cent are in a non-slum area. The study shows that 86.4 per cent elderly are

married and the rest are unmarried, widows, and divorced. About 91 percent of respondents in a slum area and 83.3per cent of respondents in non-slum area are married. To live a healthy and balanced life education is a must. It is found that 38.4 per cent elderly are illiterate and the rest are literate. Interestingly, it is observed that a large number (76%) of elderly are in slum areas and only 13.6per cent of elderly in the non-slum area are illiterate. About 65.6per cent elderly belong to the poor class followed by 24.8per cent middle class and 9.6per cent rich class. Most (81%) of the elderly in sum areas are poor where as 55.3per cent of the elderly in the non-slum area are poor. It is observed that more than half (61%) of respondents belong to a nuclear family and 39per cent belong to a joint family in a slum area. On the other hand, 49.3per cent elderly belong to the nuclear family and 50.7per cent are from the joint family in the non-slum area.

Table 1

Distribution of Socio-Economic and Demographic Characteristics of the Elderly

<i>Characteristics</i>	<i>Category</i>	<i>Slum n (%)</i>	<i>Non-slum n (%)</i>	<i>Total n (%)</i>
Age	60-69	32(32)	21(14)	53(21.2)
	70-79	48(48)	73(48.7)	121(48.4)
	80 and above	20(20)	56(37.3)	76(30.4)
Sex	Male	59(59)	75(75)	134(53.6)
	Female	41(41)	75(50)	116(46.4)
Religion	Muslim	97(97)	113(73.3)	210(84)
	Hindu	2(2)	30(20)	32(12.8)
	Others	1(1)	7(4.7)	8(3.2)
Marital Status	Married	91(91)	125(83.3)	216(86.4)
	Unmarried	0(0)	3(2)	3(1.2)
	Widow	9(9)	21(14)	30(12)
	Divorce	0(0)	1(0.7)	1(0.4)

Education	Illiterate	76(76)	20(13.3)	98(38.4)
	Primary	24(24)	36(24)	60(24)
	SSC	0(0)	26(17.3)	26(10.4)
	HSC	0(0)	25(16.7)	25(10)
	Graduate and above	0(0)	43(28.7)	43(17.2)
Income	Poor	81(81)	83(55.3)	164(65.6)
	Middle Class	19(19)	43(28.7)	62(24.8)
	Rich	0(0)	24(16)	24(9.6)
Family Type	Nuclear	61(61)	74(49.3)	135(54)
	Joint	39(39)	76(50.7)	115(46)

Association of nutritional status of elderly with the place of residence and gender

It is found that overall 14.4per cent elderly are malnourished. Usually, people living in non-slum area get more facilities than in slum area, and our analysis support this statement. Because the analysis shows that 17per cent elderly are malnourished in a slum area and 12.7per cent of the elderly is malnourished in the non-slum area which means the slum elderly are more malnourished than non-slum elderly (Figure 3.20). About 65.2per cent elderly are at risk of being malnourished and the risk of malnutrition is higher in the slum elderly (69%) than in the non-slum elderly (62.7%). It is observed that more than half of the elderly are at risk of being malnourished. Overall only 24.7per cent elderly have normal nutrition status whereas in the slum area it is only 14per cent and in the non-slum area, it is 24.7per cent. It is clear from the analysis that the nutritional condition of slum elderly is worse than non-slum elderly.

It is found that 16.2per cent of male and 12.1per cent of female elderly are malnourished. About 68.7per cent of males and 61.2per cent of females elderly are at risk of being malnourished. Again 14.9per cent of males and 26.7per cent of female elderly have normal nutrition. The analysis shows that the nutrition status

of the elderly is significantly associated with their place of residence and gender.

In a study, it is found that more elderly were at risk of malnutrition than malnourished (Maseda, *et al.*, 2016). This study is similar to the present study because the present study also revealed that more elderly are at risk of being malnourished than the elderly who are malnourished.

In a study, the prevalence of malnutrition was higher in females (28.8%) than those in males (22.0%) (Khanam, *et al.*, 2011). But according to our study males (16.2%) of, the elderly are more malnourished than females (12.1%) elderly.

Another study found that gender was significantly associated with malnutrition or the risk of malnutrition (Maseda, *et al.*, 2016). The present study is similar to this study because gender is significantly associated with malnutrition in the present study.

Table 2
Association of nutritional status of elderly with the place of residence and gender

<i>MNA</i>	<i>Slum n (%)</i>	<i>Non-Slum n (%)</i>	<i>Male n (%)</i>	<i>Female n (%)</i>	<i>Total n (%)</i>
Malnourished	17(17)	19(12.7)	22(16.4)	14(12.1)	36(14.4)
At Risk of Malnourished	69(69)	94(62.7)	92(68.7)	71(61.2)	163(65.2)
Normal	14(14)	37(24.7)	20(14.9)	31(26.7)	51(20.4)
P-value	0.09		0.06		

Association of nutritional status with socio-economic and demographic variables

A set of socio-economic and demographic variables is selected to observe whether there is any relationship with the nutrition status of the elderly. Here socio-economic and demographic variables include age, gender, religion, marital status, education, occupation, monthly income, and family type.

It is found that age is significantly associated with the nutritional status of the elderly in both slum and non-slum areas. So, age is an important factor that influences the nutritional status of the elderly. It is observed that there is a significant association between nutritional status and marital status for slum elderly but there is no significant association between nutritional status and marital status for non-slum elderly. The analysis reveals that the nutritional status of the elderly is significantly associated with education in the non-slum area but in the case of slums it is not significant.

It is noted that the nutritional status of the elderly is significantly associated with occupation in both slum and non-slum areas. The nutritional status of the elderly is significantly associated with income in the non-slum area but it is not significant in slum areas. It is found that the nutritional status of the elderly is significantly associated with family type in the non-slum area but in the slum area, it is not associated with family type.

So it is clear from the analysis that the nutrition status of the elderly is significantly associated with their age, occupation, income, marital status, education, and family type during COVID-19 (Table 3).

According to the present study, the nutritional status of the elderly is significantly associated with education in the non-slum area. A study shows that levels of education are associated with malnutrition (Kabir, *et al.*, 2006; Timpini, *et al.*, 2011) which is similar to our study in the case of non-slum areas.

Another study shows that education was not significantly associated with malnutrition (Maseda, *et al.*, 2016) which is similar to our study on the case of the slum. Because education is not significantly associated with the nutrition status of the elderly in slum areas.

Table 3
Association of nutritional status with socio-economic and demographic variables

<i>Variables</i>		<i>Slum</i>				<i>Non-Slum</i>			
		<i>Malnutrition</i>	<i>Risk of Malnutrition</i>	<i>Normal</i>	<i>P-Value</i>	<i>Malnutrition</i>	<i>Risk of Malnutrition</i>	<i>Normal</i>	<i>P-value</i>
Age	60-69	4 (12.5)	20 (62.5)	8 (25)	.009	1 (4.8)	8 (38.1)	12 (57.1)	.000
	79-79	5 (10.4)	37 (77.1)	6 (12.5)		2 (2.7)	49 (67.1)	12 (57.1)	
	80 & Above	8 (40)	12 (60)	0 (0)		16 (28.6)	37 (66.1)	3 (5.4)	
Gender	Male	12 (20.3)	41 (69.5)	6 (10.2)	.293	10 (13.3)	51 (68)	14 (18.8)	.232
	Female	5 (12.2)	28 (68.3)	8 (19.5)		5 (12.2)	28 (68.3)	8 (19.5)	
Religion	Muslim	16 (16.5)	67 (69.1)	14 (14.4)	.676	16 (14.2)	67 (59.3)	30 (26.5)	.368
	Others	1 (33.3)	2 (66.7)	0 (0)		3 (8.1)	27 (73)	7 (18.9)	
Marital Status	Married	13 (14.3)	64 (70.3)	14 (15.4)	.055	3 (8.1)	27 (73)	7 (18.2)	.002
	Others	4 (44.4)	5 (55.6)	0 (0)		9 (36)	13 (52)	3 (12)	
Education	Illiterate	13 (17.1)	52 (68.4)	11 (14.5)	1.00	4 (20)	15 (75)	1 (5)	.046
	Literate	4 (16.7)	17 (70.8)	3 (12.5)		15 (11.5)	79 (60.8)	36 (27.7)	
Occupation	Employed	10 (11.1)	66 (73.3)	14 (15.6)	.000	1 (1.4)	47 (59.5)	23 (32.4)	.000
	Un-employed	7 (70)	3 (30)	0 (0)		18 (22.8)	47 (59.5)	14 (17.7)	
Income	Below middle	15 (18.5)	54 (66.7)	12 (14.8)	.677	18 (21.7)	49 (59)	16 (19.3)	.000
	Above middle	2 (10.5)	15 (78.9)	2 (10.5)		1 (1.5)	45 (67.2)	21 (31.3)	
Family Type	Nuclear	7 (11.5)	45 (73.8)	9 (12.8)	.202	7 (9.5)	38 (51.4)	29 (39.2)	.000
	Joint	10 (25.6)	24 (61.5)	5 (12.8)		12 (15.8)	56 (73.7)	8 (10.5)	

Logistic regression analysis of different variables on malnutrition of the elderly

The result of the logistic regression estimates of the effects of different variables on malnutrition of the elderly living in slum and non-slum areas is demonstrated in Table 4. From analysis, it is observed that non-slum elderly are 0.224 times less likely to be at risk of malnutrition than slum elderly. Again, male elderly are 2.566 times more likely to be at the risk of malnutrition than female elderly. It is noted that the elderly belonging to the age group (70-79) and (80 and above) years are 1.968 and 6.383 times more likely to be at risk of malnutrition than the elderly with 60 to 69 years of age. The analysis reveals that literate elderly is 0.773 times less likely to be at risk of malnutrition than illiterate elderly. Employed elderly is 0.713 times less likely to be at risk of malnutrition than unemployed elderly. It is also clear from the study that elderly from nuclear families is 0.606 times less likely to be at risk of malnutrition than elderly living with joint family. In the case of diabetes, the elderly with no diabetes is 0.096 times less likely to be at risk of malnutrition than the elderly with diabetes. It is found that the elderly who are suffering from any disease, is 4.323 times more likely to be at risk of malnutrition than the elderly who are not suffering from any disease. The study makes it clear that the elderly who have no sleeping problem, is 0.413 times less likely to be at risk of malnutrition than those who have sleeping problem.

So, it is observed that location, gender, age, suffering from disease, and sleeping problem are the significant factors of malnutrition among the elderly.

Table 4
*Logistic regression estimates of different variables on
malnutrition of the elderly*

<i>Characteristics</i>		β	<i>Sig.</i>	<i>Exp (β)</i>	<i>95% CI for Exp (β)</i>	
					<i>Upper</i>	<i>Lower</i>
Constant		2.158	0.035	8.654		
Location	Slum ®					
	Non-Slum	-1.497	0.011	0.224	0.071	0.707
Gender	Male	0.941	0.042	2.566	1.037	6.351
	Female ®					
Age	60-69 ®					
	70-79	0.677	0.118	1.968	0.842	4.597
	80 & above	1.854	0.026	6.383	1.243	32.766
Education	Illiterate®					
	Literate	-0.258	0.646	0.773	0.257	2.319
Occupation	Employed	-0.339	0.541	0.713	0.241	2.110
	Unemployed®					
Family Type	Nuclear	-1.072	0.246	0.606	0.260	1.412
	Joint ®					
Diabetes	No	-1.072	0.096	0.342	0.697	1.209
	Yes ®					
Suffering any Disease	No	1.464	0.002	4.323	1.734	10.776
	Yes ®					
Sleeping Problem	No	-0.884	0.633	0.413	0.183	0.932
	Yes ®					

Conclusion

The elderly are the most important and vulnerable group of the population in the community. The findings of the study show that age, occupation, and marital status are significantly associated with the nutritional status of the elderly in slum and non-slum areas during COVID-19. Most of the elderly are at risk of being malnourished.

The slum elderly is more malnourished and at risk of malnutrition than non-slum elderly. So special care is needed to improve the nutrition situation of the slum elderly in Dhaka city of Bangladesh. Since the study is conducted in an area of the country with relatively small sample size, the findings of the study may not represent the actual scenario of malnutrition of the elderly in the country. A further large-scale survey may be recommended to get the real scenario of malnutrition among the elderly in the country.

References

- BBS (2011). *Population and Housing Census 2011. Socio-Economic and Demographic Report*, National Series, Volume – 4.
- Khan, M. N., Mondol, M. N. I, Hoque, N., Islam, M.N. and Shahiduzzaman, M. (2014). A Study on Quality of Life of Elderly Population in Bangladesh. *American Journal of Health Research* 2(4): 152-157.
- Khanam, M.A., Streatfield, P.K., Kabir, Z.N., Qiu, C., Cornelius, C and Wahlin, A. (2011) Prevalence and Patterns of Multimorbidity among Elderly People in Rural Bangladesh: A Cross-sectional Study. *Journal of Health, Population and Nutrition* 29(4): 406–414.
- Krishnamoorthy, Y., Vijayageetha, M., Kumar, SG, Rajaa, S. and Rehman, T. (2018). Prevalence of Malnutrition and its Associated Factors among Elderly Population in Rural Puducherry Using Mini-Nutritional Assessment Questionnaire. *J Family Med Prim Care*, 7:1429-1433.
- Maseda A, Gómez-Caamaño S, Lorenzo-López L, López-López R, Diego-Diez C, Sanluís-Martínez V, Valdiglesias V. and Millán-Calenti, JC. (2016). Health Determinants of Nutritional Status in Community-Dwelling Older Population: The VERISAÚDE study. *Public Health Nutrition* 19(12): 2220-2228.
- Pryer, JA, Rogers, S., and Rahman, A. (2003). The Epidemiology of Good Nutritional Status Among Children From a Population with

a High Prevalence of Malnutrition. *Public Health Nutrition* 7: 311–317.

Timpini, A., Facchi, E., Cossi, S., Ghisla, M.K., Romanelli, G., Marengoni, A. (2011): Self-Reported Socio-Economic Status, Social, Physical And Leisure Activities And Risk For Malnutrition In Late Life: A Cross-Sectional Population-Based Study. *The Journal of Nutrition, Health & Aging*, 15(3): 233-238

UN (2013). *World Population Ageing 2013*. Department of Economics and Social Welfare, United Nations (UN), New York, USA.

Vellas, B., Villars, H., Abellan, G., Soto, M.E., Rolland, Y., Guigoz, Y., Morley, J.E., Chumlea, W., Salva, A., Rubenstein, L.Z., Garry, P. (2006). Overview of the MNA- Its history and challenges. *J Nutr Health Aging*, 2006; 10:456–465.

Kabir, Z. N., Ferdous, T., Cederholm, T., Khanam, M.A., Streatfield, K. and Wahlin, A. (2006). Mini Nutritional Assessment of rural elderly people in Bangladesh: the impact of demographic, socio-economic and health factors. *Public Health Nutrition* 9(8): 968-974.

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Dietary Intake and Food Habits of Urban and Rural Elderly People in Patna

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ABSTRACT

The present study was carried out to assess the dietary intake and food habits of elderly people living in rural and urban areas of Patna city (Bihar). 300 elderly people (172 males and 128 females), aged 60 years and above, were randomly selected from five villages of one Block of Patna and five wards from the Municipal area of Patna equal in numbers. The data was collected with the help of a schedule through interviews regarding the intake of food and food consumption pattern of the respondents. Results revealed that consumption of food items like pulses, roots, tubers, and fruits was higher among women, and the intake of cereal, green leafy vegetables, other vegetables, milk, oil and fats, meat and fish, and eggs was more among men than women elderly persons. Roots and tubers, sugar, and jaggery have lower intake values than their respective Recommended Dietary Allowance (RDA) values for both the sexes. Large numbers of aged people (one-third) were addicted to tobacco chewing. More than half of the aged people were vegetarian. Urban elders are more likely to take food supplements than rural. Taking breakfast and snacks is higher in urban elderly males and females and lesser in rural elderly females.

Keywords : Elderly people, Nutrition, Dietary intake, Food habits

The World Health Organization (WHO) has acknowledged that ageing and nutrition is a growing global challenge (WHO, 2010). Modifying lifestyle factors such as diet can prevent, slow, or reverse the onset of many of the chronic diseases associated with ageing. Identifying dietary patterns and specific dietary components that offer protection against chronic disease is important (Mc Kevith B., 2005). Proper diet is a key concern for senior citizens because nutrition plays a major role in the prevention and management of serious diseases occurring in the elderly. Poor nutrition can cause problems in the various systems of the body such as circulatory, digestive, respiratory, psychological, and immune systems. To be healthy, older people are needing to eat what adults eat, with primary differentiation in the number of calories, as the calorie needs to decrease with age (Christodoulou, and Kontaxakis, 2000).

Nutrition plays a very important role in the elderly as well as it helps to prevent, by following some simple diet plans, serious problems associated with nutrition (Moisiadis, 2004). Simple things like beans, almonds, walnuts, oranges, broccoli, and others can provide vitamins and minerals such as vitamin C, vitamin B, folic acid, and zinc (Kourkouta L, *et al.*, 2015). Numerous factors are involved in determining eating habits including gender, marital status and household composition, socio-economic position, income, physical activity, smoking, body mass index (BMI), and health but the influence of these factors on eating habits has received little consideration among older adults (Helldam, *et al.*, 2012).

Good health is the pre-requisite for good “quality of life” and nutrition is the key to good health because energy is required to help in normal function and physical activities, growth, and repair of damaged tissues of the body, and this energy is provided by oxidation of nutritional protein, fat, carbohydrate, etc. Nutritional status is influenced by the amount of each essential nutrient that is consumed and is also influenced by medical, physiological, psychological, and social variables. Encouraging better nutrition and physical exercise is a cost-effective way of decreasing the progression of age-related diseases (Fiatarone, *et. al.*, 1994; Morley, 2001). As people age,

adequate nutrition promotes the maintenance of health, physical performance, and psycho-social well-being (Bates, *et al.*, 2002; Nijs, *et al.*, 2006).

The objective of this study was to understand the food habits and their influences on the health of urban and rural elderly

Materials and Methods

300 elderly people (172 males and 128 females), aged 60 years and above, were randomly selected from five villages in one Block of Patna and five wards from the Municipal area of Patna city (Bihar) equal in numbers. The data was collected with the help of a schedule through an interview regarding the intake of food and food consumption pattern of the respondents. Standard household measures including containers of five consecutive sizes, spoons, and glasses were shown to the subjects to help them to indicate the exact amount of food consumed by them. A dietary survey was carried out by 24 hours recall method. The mean daily intake of different food groups was calculated and compared with a balanced diet given by National Identification Number (NIN). Simple arithmetic mean with standard deviation was calculated to interpret the results.

Table 1
Mean Food Intake of Rural Elderly People by Sex

<i>Food Items</i>	<i>Male</i>			<i>Female</i>		
	<i>Mean</i>	<i>S.D.</i>	<i>RDA</i>	<i>Mean</i>	<i>S.D.</i>	<i>RDA</i>
Cereals(g)	313.43	82.883	350	325.54	67.114	222
Pulses(g)	96.22	40.172	50	96.63	41.164	40
Roots & Tubers(g)	98.63	60.652	200	137.24	88.994	150
Green leafy vegetables(g)	231.76	110.594	50	326.74	445.660	50
Other vegetables(g)	207.47	116.957	100	198.58	123.492	100
Fruits(g)	196.25	122.546	200	200.00	134.629	200
Milk(g)	373.38	207.679	300	338.89	162.178	300
Oils & fats(g)	23.37	5.966	25	25.29	9.039	20
Meat & fish(g)	214.71	132.009	50	250.00	173.205	40
Eggs (g)	93.75	49.552	50			40
Sugar & jaggery (g)	16.76	7.715	20	16.36	9.209	20

Table 1 gives details of 11 food items commonly used by elderly people by their sex. The mean intake value of food items like pulses, green leafy vegetables, other vegetables, milk, meat, and fish was higher than the respective Recommended Dietary Allowance (RDA) for each item for both male and female elderly people. While consumption of green leafy vegetables, meat, and fish was better among women than men, that of other vegetables and milk was better among men than women in elderly people respectively. Consumption of pulses was similar among the elderly of both sexes. The mean intake value of roots and tubers, sugar, and jaggery was lower than the respective RDA value among the men as well as women elderly persons. As regards the consumption of other items, while roots and tubers were consumed more by women than men, sugar and jaggery were equally consumed by elderly persons of both sexes. Likewise mean intake value of cereals, fruits, and oil and fats was lower than the respective RDA value among men and higher than the respective RDA value among women and elderly persons. Likewise, consumption of these items was higher among women than men. Eggs were reported to be consumed mainly by men and have a higher intake value than their RDA value.

Table 2
Mean Food Intake of Urban Elderly People by Sex

<i>Food Items</i>	<i>Male</i>			<i>Female</i>		
	<i>Mean</i>	<i>S.D.</i>	<i>RDA</i>	<i>Mean</i>	<i>S.D.</i>	<i>RDA</i>
Cereals(g)	327.59	76.560	350	300.51	80.682	222
Pulses(g)	92.99	50.091	50	96.33	52.601	40
Roots & Tubers(g)	99.04	49.991	200	108.33	73.899	150
Green leafy vegetables(g)	274.62	128.429	50	264.66	130.118	50
Other vegetables(g)	220.57	122.197	100	197.43	96.016	100
Fruits(g)	205.47	110.303	200	209.52	117.918	200
Milk(g)	419.01	201.134	300	415.52	212.175	300
Oils & fats(g)	25.06	8.529	25	23.46	7.085	20
Meat & fish(g)	234.62	98.710	50	142.86	53.452	40
Eggs (g)	87.50	23.146	50	83.33	28.868	40
Sugar & jaggery (g)	18.17	10.373	20	18.94	10.781	20

Mean intake values of 11 common food items consumed by both men and women elderly persons in urban areas are shown along with respective S.D. and RDA values in table 2 above. Almost all the items (except roots and tubers, sugar, and jaggery) have higher mean intake values than their respective RDA values among men as well as women elderly persons respectively. Roots and tubers, sugar, and jaggery have lower intake values than their respective RDA value for both the sexes.

While consumption of food items like pulses, roots, tubers, and fruits was higher among women, the intake of cereal, green leafy vegetables, other vegetables, milk, oil and fats, meat and fish, and eggs was more among men than women elderly persons. Intake of sugar and jaggery was similar among the elderly of both sexes.

Table 3
Distribution of aged people according to the type of diet

<i>Type of diet</i>	<i>Urban</i>		<i>Rural</i>		<i>Total</i>	
	<i>No.</i>	<i>Percentage</i>	<i>No.</i>	<i>Percentage</i>	<i>No.</i>	<i>Percentage</i>
Vegetarian	79	52.7	76	50.7	155	51.7
Non-vegetarian	71	47.3	74	49.3	145	48.3
Total	150	100.0	150	100.0	300	100.0

The type of diet consumed by the elderly people is given in table 3. It is clear that 52.7 percent of the aged people consumed vegetarian foods and 47.3 percent consumed non-vegetarian foods in urban areas. While in rural areas 50.7 percent of the aged people consumed vegetarian foods and 49.3 percent consumed non-vegetarian foods

Slightly more than half of the aged people were vegetarian and less than 50 % were non-vegetarians. Non-vegetarian foods contain saturated fats which may result in the deposition of fat in the blood vessels. Saturated fat intake, also leads to obesity in the long term. However, the majority of the elderly were lesser at risk of obesity or thickening of blood vessels.

Table 4
*Distribution of aged people according to taking
 supplement foods*

<i>Supplement foods</i>	<i>Urban</i>		<i>Rural</i>		<i>Total</i>	
	<i>No.</i>	<i>Percentage</i>	<i>No.</i>	<i>Percentage</i>	<i>No.</i>	<i>Percentage</i>
Vitamin supplement	56	37.3	35	23.3	91	30.3
Mineral supplement (calcium/iron)	47	31.3	24	16.0	71	23.7
Total	150	100.0	150	100.0	300	100.0

The distribution of aged people according to intake of supplement foods in table 4 revealed that 37.3 percent of the aged people take a vitamin supplement daily and 31.3 percent take a mineral supplement (calcium, iron) daily in an urban area. While in rural area 23.3 percent of the aged people take vitamins supplement daily and only 16 percent take the mineral supplement (calcium, iron) daily. Thus, urban elders are more likely to take food supplements than rural. Vitamin supplement was more popular than mineral supplement among both urban and rural elderly persons.

Table 5
*Distribution of aged people according to daily meal patterns
 according to urban and rural residence*

<i>Type of meal</i>	<i>Urban</i>		<i>Rural</i>		<i>Total</i>	
	<i>No.</i>	<i>Percentage</i>	<i>No.</i>	<i>Percentage</i>	<i>No.</i>	<i>Percentage</i>
Breakfast	141	94.0	119	79.3	260	86.7
Lunch	148	98.7	144	96.0	292	97.3
Snacks	131	87.3	101	67.3	232	77.3
Dinner	148	98.7	149	99.3	297	99.0

Regular food consumption and time intervals among meals are related to biological and physiological processes in human beings. It is usual to plan the main meal each day with other lighter meals at approximately 4-hour intervals. This is roughly the period taken to digest any meal completely, after which the flow of gastric juices in the stomach causes an increasing sensation of hunger.

The above table revealed that in urban areas 94 percent of the elderly people used to take morning breakfast which was 79.3 percent in the case of rural elderly people. Further, 67.3 percent of rural elderly used to consume snacks while it was more prevalent in urban which constituted 87.3 percent. 98.7 percent of urban elderly have had lunch while the figure was 96 percent in rural elderly people and about 99 percent of elderly have had dinner in urban and rural areas respectively.

It was evident from the table that breakfast and snacks were more common among the elderly in urban areas than in rural areas. Lunch and dinner were the main meals both in urban and rural areas. Urban-rural differences were seen in the daily food pattern of elderly people.

Table 6
Distribution of aged people by sex according to the daily meal pattern

Type of meal	Urban				Rural			
	Male		Female		Male		Female	
	No.	%	No.	%	No.	%	No.	%
Breakfast	76	95.0	65	92.9	75	81.5	44	75.9
Lunch	79	98.8	69	98.6	88	95.7	56	96.6
Snacks	72	90.0	59	84.3	70	76.1	31	53.4
Dinner	79	98.8	69	98.6	92	100	57	98.3

The study reveals that there is a slight difference in taking morning breakfast among males and females such as 95%, 93% in urban elderly people and 81.5%, 76% respectively in rural elderly people. The table also shows that taking lunch was more common than other types of meals both among males and females in urban as well as a rural areas. However, taking regular evening snacks was more common among urban male and female elderly i.e. 90 percent and 84.3 percent respectively than among 76.1 percent male and 53.4 percent female rural elderly people. As far as dinner is concerned the study reveals that almost all the urban and rural elderly males and females take dinner at night regularly (i.e. 99 percent male and cent percent female elderly).

It may be concluded that taking breakfast and snacks is higher in urban elderly males and females and lesser in rural elderly females. It appears that urban elderly are conscious of their health but female elderly of rural areas do not care much about their health.

Table 7
Distribution of aged people according to habits

<i>Habits</i>	<i>Urban</i>				<i>Rural</i>			
	<i>Male</i>		<i>Female</i>		<i>Male</i>		<i>Female</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Use smoking	9	11.3	1	1.4	13	14.1	2	3.4
Tobacco chewing	28	35.0	2	2.9	31	33.7	3	5.2
Use Alcohol	10	12.5	1	1.4	20	21.7	-	-

Table no. 7 shows the details of habits, 11.3 percent of the male and 1.4 percent of female aged people in the urban area used smoking, 35 percent of males and 2.9 percent of females were addicted to tobacco chewing and 12.5 percent of males and 1.4 percent of females of the urban aged people were used to alcohol. Further, in rural areas, 14.1 percent of males and 3.4 percent of females of the aged people use smoking, 33.7 percent of males and 5.2 percent of females were chewing tobacco, and 21.7 percent of males of the rural aged people used alcohol. None of the rural elderly females consumed alcohol.

Thus, it may be inferred from the table that in urban as well as rural areas, a large number of aged people (one-third) were addicted to tobacco chewing. More than one-fifth of elderly men were addicted to alcohol in rural areas. The use of intoxicants was more prevalent in rural than in urban areas and more among men than women in both areas. However, only 34 percent of the elderly in urban and 46 percent in rural areas were used to smoking, tobacco chewing, or taking alcohol. Tobacco chewing was more common among both rural and urban elderly persons, particularly men.

Conclusion

The study reveals that the mean intake value of certain food items like pulses, green leafy and other vegetables, milk, meat, and fish was higher than their respective RDA value for rural elderly men as well as women. On the other hand, the mean intake value of cereals, fruits, oils, and fats was higher than their RDA value among rural elderly women and lower among rural elderly men. In urban areas all the food items except roots and tubers, sugar, and jaggery) have a higher mean intake value than the respective RDA value for elderly persons of both sexes. The use of intoxicants like smoking, tobacco chewing, and alcohol was higher among men than women in the elderly and more in rural than urban areas. Tobacco chewing was more popular than smoking and alcohol among elderly men in rural and urban areas. Vegetarian food was more common than non-vegetarian food among elderly living in both urban and rural areas. Vitamin supplement was more popular than mineral supplement among rural as well as urban elderly. Urban elderly preferred to consume supplements more than their rural partners. Among the type of daily meals, lunch and dinner were more common than breakfast and snacks among the elderly in rural and urban areas. Urban elderly preferred snacks and breakfast more than rural elderly.

Recommendation

A healthy lifestyle and food habits should be maintained through adopting healthy lifestyle practices. Consumption of harmful substances such as cigarettes, drinking, tobacco, etc. should be avoided or restricted. Elderly subjects should be encouraged to include iron and micronutrient-rich foods (fruits and green leafy vegetables) in their daily dietaries. Government, NGOs, community, families, and medical and social science faculties need to give greater emphasis to provide health care, societal support, and nutrition services to the elderly.

References

- Bates CJ, Benton D, Biesalski HK, Staehelin HB, Van Staveren W, Stehle P, Suter PM, Wolfram G.(2002): Nutrition and Aging: A Consensus Statement; *J Nutr Health Aging.*, 6: 103–160.

- Christodoulou, C., and Kontaxakis, B. (2000): *The third age*. Athens, (Greek)
- Fiatarone, MA., O'Neill, EF., Ryan, ND., Clements, KM., Solares, GR., Nelson, ME., Roberts, SB., Kehayias, JJ., Lipsitz, LA., Evans, WJ. (1994): "Exercise training and nutritional supplementation for physical frailty in very elderly people". *N Engl J Med.*, 330: 1769–75.
- Helldan, T. Lallukka, O. Rahkonen, and E. Lahelma, (2012): Changes in healthy food habits after transition to old age retirement, *Eur J Public Health*, 22(4): 582-586.
- Indian Council of Medical Research (1989): *Nutrient requirements and recommended dietary intake for Indians*.
- Kourkouta L, Papathanasiou I, Koukourikos K, Kleisariis Ch, Fradelos E, Tsaloglidou A. (2015): Nutritional habits in the elderly, *Pharm Pharmacol.* 3:591-95.
- Mc Kevith B. (2005): Diet and healthy aging. *Journal of the British Menopause Society*, 11(4):121–125.
- Morley JE Anorexia, sarcopenia, and aging. *Nutrition*, 2001; 17: 660–663.
- Moisiadis, G. (2004): *Third age problems and deal it*. Thessalonikh: Grafikes Texnes,
- WHO (2010): Nutrition for older persons. (<http://www.who.int/nutrition/topics/ageing/en/index.html>, accessed 18 April 2010).
- Nijs, KA., de Graaf, C., Siebelink, E., Blauw, YH., Vanneste, V., Kok, FJ., van Staveren, WA. (2006): Effect of family-style meals on energy intake and risk of malnutrition in dutch nursing home residents: a randomized controlled trial; *J Gerontol A Biol Sci Med Sci.*, 61: 935–42b.
- Vijayaraghvan K, Brahman GNV, Balakrishna N and Kumar S. (2004): Report on diet and nutrient status of elderly. National Institute of Nutrition, ICMR.

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Reaching the Unreached – A Model of Health Care Services for Rural Elderly

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ABSTRACT

This study is a report of a camp organized by the geriatric clinic of BLDE DU Shri B M Patil Medical College Hospital and Research Centre, Vijayapura(Karnataka) during the COVID- 19 wave under a scheme named- the 'Reaching the Unreached' programme. One hundred elderly (63 males and 37 females) people registered for the camp on 31/12/2021. The common diseases noted were Hypertension (17%), osteoarthritis (14%), Diabetes (08%), Anaemia (08%), Cataract (05%) Stroke (03%), and heart diseases (03%), while 20 percent of elderly did not have any disease. This camp not only recognized the health issues among the elderly population, but it has also solved major issues like accessibility, affordability, and consistency. This study also proves that the model used by this camp in providing health services to the elderly is cost-effective, sustainable, and reproducible.

Keywords : Health camp, Elderly, Rural, COVID-19.

In India, it is estimated that three-fourths of the elderly population reside in rural areas, while 70 percent of the rural elderly are dependent on others. (Report on status of elderly in India, 2011). The elderly in rural areas do not seek health care services due to unaffordability (Agrawal, *et al.*, 2015). In a study by Indumathi, and Vinayagaram, (2020), it was observed that there is less compliance with medicine use among rural elderly (46%) and high cost involved (21%).

The geriatric clinic of Shri B M Patil Medical College Hospital, and Research Centre, Vijayapura (Karnataka) adopted Arjunagi village (district Bijapur) for Health care services for the elderly people. This village is 40 kilometers from the medical college hospital.

The camp was supported by an NGO named Anand Trust, which initiated this idea and also provided 50 percent of the medicines. The Geriatric Clinic of the medical college provided a vehicle for transport, manpower, postgraduate students and interns, and the remaining 50 percent of medicines. Gram Panchayat of Arjuangi provided a hall for the camp which had senior citizen-friendly facilities. The National Program Health Care of Elderly (NPHCE) Vijayapura, provided educational materials, while the National Service Scheme of KCP Science College provided volunteers. All the services were coordinated by a Geriatrician.

The reasons for choosing this village:

- a) The elderly of this village were not able to reach the hospital due to lack of transport facilities in the lockdown period.
- b) The elderly with disabilities, staying alone, frail and, below the poverty line, who could not afford to reach the health care facilities and
- c) Non-availability of regular medicines for diseases like diabetes, hypertension, heart ailments, and osteoarthritis in the primary health center during a pandemic.

Aims of the camp were:

1. to provide healthcare services to those elderly who could not reach us. Hence the phrase “reach the unreached”.
2. to provide health services like screening for the diseases and treatment of chronic diseases in the elderly residing in the specified village both accessible and affordable.
3. to promote preventive measures through awareness talks and Immunization
4. to enhance compliance to medicines and ensure the availability of medicines regularly at free of cost.
5. to analyze the demographic pattern of utilization of services, the prevalence of diseases in a study population, and the impact of health care services provided.

Method*Sample*

410 senior citizens were residing in the village. Out of these elderly people one hundred elderly were registered for the camp for receiving the ongoing health services provided by the hospital.

Among 100 registered elderly persons, 63 were male and 37 were females, which includes two bedridden patients. The oldest patient was 92 years old male. Regarding age distribution, 84 percent were in the age group of 60-74years, 14 percent were in the age group of 75-84 years, and 02 percent were in the 85 + Years age group. (Table -1)

Table 1*Age and Sex Distribution (n = 100)*

<i>Age group (Years)</i>	<i>Number</i>	<i>%</i>	<i>Number</i>	<i>%</i>
60-74	51	51%	33	33%
75-84	10	10%	04	04%
More than 85	02	02%	00	00%
	63	63%	37	37%

Procedure

Health services like Geriatric Assessment, blood pressure, blood sugar levels, and weight were measured in all patients during every visit. A home visit for the bedridden was also carried out. Awareness talks on various health issues were organized once in six months. The patients who required additional health services were provided a referral letter and were referred to B M Patil Medical College Hospital for further evaluation and treatment. The medicines required for the patients were provided free of cost.

Results*Common diseases*

The common diseases noted were Hypertension (17%), Osteoarthritis (14%), Chronic bronchitis (10%), Diabetes (08%), Anaemia (08%), Cataract (05%), Heart disease (05%), Post-stroke (04%), Bronchial Asthma (03%), Valvular heart diseases (03%), Parkinson's (02%), Depression (02%), Dementia (01%) and Epilepsy (01%) either in a single or in combination, while 20 percent of elderly did not have any disease. These elderly persons visited the camp for a general check-up and they motivated other elderly persons to attend the camp. (Table -2) Diseases in a combination of two and three were seen in many patients.

Table 2
Comorbidities

<i>Name of the Disease</i>	<i>Number</i>	<i>%</i>
Hypertension	17	17
Osteoarthritis	14	14
Chronic bronchitis	10	10
Diabetes	08	08
Anemia	08	08
Cataract	05	05
Ischemic Heart Disease	05	05

Post-stroke	04	04
Bronchial Asthma	03	03
Valvular Heart Diseases	03	03
Parkinson's Disease	02	02
Depression	02	02
Dementia	01	01
Epilepsy	01	01
Cancer Breast operated	01	01
No diseases	20	20

Disabilities

The most common disability seen was partial blindness (08%), hearing impairment (08%), Parkinson's (02%), and, dementia (01%), while the commonest aids used were walking stick, spectacles, and hearing aids.

Follow up rate

Every month 25-30 elderly patients visited the camp and got examined for their health and got blood sugar and blood pressure measured and then collected medicines for one month. Five patients were referred for detailed evaluation and treatment to the medical college hospital and all five have visited B M Patil Medical College Hospital.

Mortality

In the last fifteen months, two deaths were reported among the registered patients.

Discussion

Male dominance (63%) was seen in receiving health care services in this study. It is similar to a study by Kusuma (2015), while equal proportions of males and females were reported by Agrawal, *et al.*, (2015) and Narapureddy, *et al.*, (2012) whereas Indumathi, (2020) reported female dominance.

Regarding age distribution, in our study 73 were in the age group of 60 to 70 years while 57 were in a study by Indumathi., (2020) and 72 percent in a study by Lena, *et al.*, (2009).

The most common disease noted in our study group is Hypertension in 17 percent, Arthritis in 14percent, Diabetes in 08percent, and heart disease in 05percent, whereas Hypertension in 39percent, Arthritis in 56percent, Diabetes in 25percent, and heart disease in 19percent, respectively were reported in the study by Kusuma., (2015).

In this study, 20percent, of the elderly were healthy and not suffering from any diseases while it was 6percent, in a study by Nair (1989) and 30percent, in Kusuma, (2015).

All the elderly people in this study group were below the poverty line. The middle and rich-class people visited hospitals in nearby bigger cities. In a study by Agrawal, *et al.*, (2015), the people of low socioeconomic class constituted 50percent, similar in the study by Sanjel, S.,*et al.*, (2012)

Impact of the camp

The regular camp in the same village helped in:

- 1) diagnosing new cases of Diabetes mellitus in 4, Cataracts in 5, and, Hypertension in 3 elderly people.
- 2) to improve compliance to medicines and good control of diseases as we were providing an uninterrupted supply of medicines which had a positive impact on the Quality of Life of elderly people.
- 3) providing first-hand experience of rural geriatrics to postgraduate students and interns of B M Patil Medical College.
- 4) The camp continued to screen all the new patients for diseases and provided consultation and medicines.
- 5) Created awareness about the prevention of diseases like Malaria and Dengue.

Implications

The strength of this study was that it brought the real scenario of the health status of the rural elderly from the clinician's point of view and not by the questionnaire method. This activity was carried out for 15 months and provided health care services to the elderly who were not able to reach the hospital for reasons like being 1) differently-abled 2) having no caregivers and 3) could not afford to visit hospitals. Teamwork involving Private Medical colleges, NGOs, Government schemes, and, support from gram panchayat, helped 'reach the unreached in a cost-effective and sustainable model.

This camp not only recognized the health issues among the elderly population, but also solved major issues like accessibility, affordability, and consistency. This camp mainly catered to the needs for screening, and management of Non-Communicable Diseases. This study may be helpful to policymakers in drafting public health reforms for the rural elderly.

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References

- Agrawal, Nipun., Shrotiya, Ved Prakash., Singh, Atul Kumar, and Initaz, Danish.,(2015): Healthcare services utilization by geriatric population in a rural area of District Bariely, India. *International Journal of Current Microbiology and Applied Sciences*. 4,(5); pp.720-727.
- Indumathi, R., and Vinayagaram, A., (2020): A Study on utilization of health care facilities among rural elderly in Kanyakumari district. *The International Journal of analytical and experimental modal analysis*. 22 (11)
- Ksusma. A.,(2015): A study on health status of elderly in rural areas need for social work intervention. *International Journal of Research and Analytical Reviews*.2, (4)

- Lena, A., Ashok, K., Padma, M., Kamath, V., Kamath, A. (2009): Health and Social Problems of the elderly: a cross-sectional study in udupi taluk , Karnataka. *Indian J Community Med.* 34, (.2). pp 131-4.
- Nair, P.S. (1989): The Aged in Rural India; A Study of the Socio-Economic and Health Profile S.N. Singh, M.K. Premi, P.S. Bhatia and Ashish Bose, Population Transition in India, vol.2, B.R. Publishing, Delhi.
- Narapureddy, B., Naveen, KH., Madihati, P., Singh, K., Pirabu, RA (2012): Sociodemographic profile and health care seeking behavior of rural geriatric population of Allahabad district of UP: A cross-sectional study. *International Journal of Med Sci Public Health.* Vol 1. pp 87-92.
- Rao, *et al.*, (2003): Health status of the rural aged in Andhra Pradesh; A sociological perspective, *Help Age India-Research and Development Journal*, Vol.9, No.2.
- Registrar General of India. (2006): Socio-cultural Tables of India, 2001-Data on CD, Office of the Registrar General of India New Delhi.
- Singh, C.P. (2005): Socio-economic status and Health Conditions of landless Rural Aged in Haryana, *Help Age India-Research and Development Journal*, 11,(1)
- Sanjel, S., Mudbhari, N., Risal, A., Khanal, K. (2012): The utilization of health care services and their determinants among the elderly population of Dhulikhel municipality. *Kathmandu University Medical Journal*, 10, (37), pp 34-39

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A Study of the Elderly Living in the Old Age Homes of Varanasi

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ABSTRACT

The purpose of this qualitative study was to find out the reasons behind the relocation of the elderly to the Old Age Homes (OAHs). Twenty elderly inmates (both males and females), aged between 61 to 86 years, residing in the sampled OAHs of Varanasi, were interviewed individually. The findings revealed that the elderly shifted to OAHs because of misfortune, death of a spouse, familial discord, loneliness, economic hardship, etc. The respondents revealed that their movement to OAH in Varanasi was involuntary and not happened out of their volition. The inmates considered it their misfortune (past karmas) that they are forced to spend the last days of their lives in OAHs rather than with their families.

Keywords: Old Age Home, Varanasi, Karma.

Traditionally elderly played an important position in the Indian family structure. Children regarded them as the pillar of strength and epitome of love. They participated in not only religious and

social activities but also in familial and community matters. However, the forces of industrialization and urbanization resulted in increased individualism and the formation of nuclear families (Jamuna, 1999). Thus, the transformation of the nature and pattern of intergenerational relationships has altered the social security and quality of care available to the elderly. In short, the rise of the elderly population and the transition of societal values have triggered a quest for new solutions to deal with the challenges posed by demographic transition.

The existing literature identifies various factors that trigger the relocation of the elderly to the OAHs. Kalvar and Jamuna (2008), for instance, identify the main reasons for relocation as childlessness, intergenerational strife, and inability to survive independently at the loss of a spouse. Lamb (2013) posits the main reason for relocation is the perceived redundancy of the elderly in their twilight years. In a different vein, Rajan (2002) reasons the relocation to the lack of caregiving facilities at home and out-migration of the children. On the other hand, Mishra (2008) contends that relocation to OAHs provides a sense of satisfaction to the elderly by the way of living separately from their children. Chand and Chatterjee (2019) studied the role of caregivers in providing support and assistance, maintaining close interaction, offering nutrition and health care, and facilitating a dignified death of the elderly in Varanasi.

The objective of this study was to have a phenomenological understanding of the reasons behind the relocation of the elderly to Old Age Homes (OAHs) in Varanasi. The study also aimed to understand the philosophy of life of the inmates residing in the OAHs and their coping mechanism to generic life stress through their lived experiences. Derivatively, the study also attempted to develop an understanding of familial dynamics in contemporary society through the first-hand narrative shared by the residents of these OAHs with the researchers.

Method*Sample*

A total of 20 respondents from the Missionaries of Charity and Vridhjan Awas, were interviewed. Both the OAHs are located in Varanasi City and are charity-based and hence accommodated residents free of charge. The OAHs were shortlisted based on purposive sampling as the idea was to develop an 'emic' understanding of the lives of the inmates in the free OAHs of Varanasi. Among the respondents, 55 percent (N=11) were males and 45 percent (N=9) were females and the average age of the respondents was 72 years. All the participants were healthy, conscious, and mentally fit individuals for the study. Most of the inmates were from lower socio-economic backgrounds and were petty job holders like hotel waiters, carpenters, security guards, textile industry workers, tailors, etc. (see table 1). However, their relocation to OAH was not solely triggered by their financial condition but also by other socio-psychological factors as well. In reporting the findings, pseudonyms were used for maintaining the confidentiality of the research subjects.

The qualitative methods-observation and in-depth interviews were used for gaining an emotive understanding of the research subjects. Before conducting the interviews with the participants, a meeting was held with the managers of the respective OAHs and they were informed of the purpose of the research and their consent for interviewing the inmates was sought. After receiving their consent, the respondents were interviewed at their convenient place i.e. their rooms or dormitories. The participant's consent was taken before beginning the interview process and he/she was given the option to quit the interview at any point in time without explaining. Apart from recording the interviews, field notes were taken for discerning the contextual information.

Table 1
Brief demographic profile of the respondents

<i>Sl. No.</i>	<i>Name</i>	<i>Gender/Marital Status</i>	<i>Age</i>	<i>Job</i>	<i>Duration of the stay</i>
1	Ravindra Mishra	M/Widower	61	Worker in a textile industry	04 years
2	Meena	F/Unmarried	62	Clothes sewing	03 years
3	Rajesh Pandey	M/Widower	73	Private job	05 year
4	Rajendra Kumar	M/Widower	82	Worker in a textile industry	05 years
5	Aruni Ghosh	F/Unmarried	85	Sweeper	09 years
6	Vijendra	M/Unmarried	70	Mason	01 year
7	Rajbali	M/Widower	72	Security Guard	01 year
8	Rakesh Kumar	M/Married	70	Auto driver	06 months
9	Ashok	M/ Married	75	Tailor	08 months
10	Vimla	F/ Married	72	Housewife	08 months
11	Kamla Devi	F/Married	62	Housewife	04 months
12	Lata Singh	F/Widowed	65	Housewife	12 years
13	Manra Devi	F/Widowed	76	Housewife	03 years
14	Sheela Devi	F/Widowed	80	Housewife	18 years
15	Narendra	M/Married	70	Wage labor	08 years
16	Sushila	F/Married	65	Housewife	08 years
17	Arbind	M/Widower	86	Tailor	04 years
18	Tribhuvan	M/Married	71	Worker in a textile industry	09 months
19	Neelam	F/Married	70	Housewife	09 months
20	Anand	M/Widower	72	Carpenter	06 years

Findings

Interviews revealed that most of the inmates reasoned their relocation to the OAH to their '*karma*' or action. For instance, Mr. Rajesh Pandey has been residing in the Missionaries of Charity for the last 5 years and he relocated after the demise of his wife. He had 4 sons and 2 daughters, all of whom met premature deaths. His

misfortune continued and he lost his eyesight and decided to join the OAH. He blames his *karma* for all the misfortune in his life and believes that his sufferings are a way of paying the karmic debts. He shared:

All the sufferings are a result of my karma. I may have done something very wrong in my previous life for which I am suffering now.

Mr. Pandey also shared his views about death and *moksha* (salvation) in Kashi. He pointed out that death is a part of the natural cycle of life and signifies a transition to a new life. He elaborated:

People relocate to Kashi in the last days of their lives for attaining salvation. But salvation does not come easy. It will come only after you have suffered your karma. That is why there are people who do not die even after staying at Kashi for a long time. People eagerly want moksha from the cycle of rebirth as life is full of sorrow and suffering. They are completely fed up with their lives.

Mr. Rajendra Kumar relocated to the OAH because of similar untoward incidents in life. He had three marriages but none of his wives survived. Earlier he was living with his son but after the unfortunate death of his daughter-in-law, he relocated. He shared his philosophy of life in the following words and used the appended Tulsī verses to describe his feelings:

I never feel sad about anything in life. I believe whatever fate has in store for us, will happen. I was destined to do penance at an OAH in Kashi, so I am here. It's all a game of luck. I have now become a renouncer....I don't think much now.

कर्मप्रधानविश्वरचिराखाजोजसकरइसोतसफलचाखा'

Sheela Devi, an octogenarian has been residing in the OAH since 2003. After her husband expired in 1999, she shifted to her son's place. Three years later there was a robbery in her son's house and

1. According to the law of this world, you have to suffer the fruits of your action.

her son was murdered. This led to her depression and she shifted to the OAH. She narrated:

After the robbery happened, my daughter-in-law with her children shifted to her maternal home. I got depressed, lost my memory, and my brother's son brought me to Patna. One day, I left their house and caught a train to Varanasi. After arriving here, I did not realize that I have come to Varanasi. My memory came back after three years. I am grateful to the manager of this OAH and the students of Banaras Hindu University for helping me to get my memory back....I don't know what sins I have committed that I witnessed the murder of my son with my own eyes. What could be more painful than this?

Mr. Ravindra Mishra, a 66-year-old person, has been residing in the OAH for the last four years. His wife expired in 2017 after suffering a prolonged illness. He stayed with his daughter until his house was destroyed in a fire and he fractured his leg badly in that accident. After the incident, Mr. Mishra shifted his daughter to his in-law's place and relocated to the OAH. Reasoning his misfortune, Mr. Mishra elaborated:

I always recall my happy days with my family. I keep thinking about my wife and daughter. The whole incident ruined my life. Today I would be earning my living by myself and not depending on a charity like this. Sometimes it brings tears to my eyes. Tears of sorrow start flowing. Maybe I am being punished for my wrongdoings...My karma is such that I have to stay in an OAH away from my kith and kin.

Likewise, Ms. Meena Basu, an unmarried resident, shifted to the OAH after her brother's death in a road accident. She was very sad about the incident and relocated. She believed that her sufferings are due to her *karma* and her penance is a way of paying off her karmic debts for a better rebirth. As she explained:

I believe that whatever has happened to me is because of my karma. This is the way of paying karmic debts. I have no one in this world, neither my parents nor my brother. That is what your action does. Maybe I have done something wrong in my previous birth, for which I am suffering now

Mr. Ashok and his wife, Vimla, shifted to the Vridhjan Awas in 2021. Mr. Ashok used to do tailoring work and his work suffered due to the corona pandemic. Their sons also did not help him in those trying times and they shifted to this OAH. They resented the idea of staying in free OAH and living on charity. They tacitly posited:

We feel bad that we are consuming free food. This is disgraceful and sounds like begging to us. This is the result of our karma.

Some inmates identified familial discord as the reason for their shifting to OAH. For example, Mrs. Lata Singh has been residing in the OAH for the last 12 years. Her relocation was triggered by the loneliness and neglect that she experienced at her home. She recalled:

My daughter-in-law used to misbehave with me. My son ignored such issues. Both of them hardly spoke to me. That's why I decided to relocate here. It is my karma and luck that destined me to spend my last days in OAH. If my karma was good, I would be happy living with my family....Please note that I was born to a prosperous and elite family. But today I am residing in a free OAH. This is destiny. If my son does not want to take care of me, what can be done?

Similarly, Mr. Rakesh Kumar shared how the familial ordeal made him take the drastic decision. He shared how his family members neglected him after he got injured at work. He elaborated:

Till the time I was earning, I was well respected at home. When I was injured, I was not offered proper medical treatment. My son did not give me a penny. I was realizing

that the wound was increasing slowly..... I am one of the very few unfortunate parents who have been physically assaulted by their children. Considering all these incidents, I decided to relocate. If a person has to shift to an OAH, despite having his own house, wife, and children, that is the biggest misfortune that can possibly befall him.

Ms. Aruni Ghosh, an unmarried octogenarian, was of the firm belief that her relocation to Varanasi is a part of the divine plan. She observed fatalistically:

Whatever happens in life happens for a reason. I have lived a life according to my karma. Now I am waiting for my death and to be with the Lord. My only desire is to attain salvation by dying in Varanasi. That's why I do not fear death. I wish that my last rites should be performed with all intent, whether by this institution or by my brother or niece.

In sharing his adjustment process at OAH, Mr. Rajendra Kumar posited that initially, the environment of the institution seemed alien. But he started feeling good once he got acquainted with everybody. He narrated his experience:

*अपने गाँव के ताल तलैया, घनबागियों के छावरे।
स्वर्ग से सुंदर लागै भैया अपना गाँव गिरावरे।²*

No matter how much happiness a new place offers, it always feels awkward initially. But slowly one gets adjusted and starts feeling good. Now I don't feel like going home. I believe in giving my son his own space. I will remain here for the rest of my life. I have moved beyond the mundane attachments of life and hence I don't long for going to my house or meeting my son. My dead body will go from here.

2. One's home/locality is the best and there is no place like home and locality.

However, adjustment differences were observed between the newly joined inmates and long-term residents. The long-term residents were well-adjusted in OAHs and acquainted with the living conditions. However, as their memories of familial discordance/ill-will have faded away, they have developed nostalgia/attachment towards their families and bygone days. They feel anguish and long for seeing their family members. For instance, Mr. Rajendra has two grandchildren who live with their maternal grandmother. He desires to see them, but his age does not permit him to travel. As his grandsons are too young, they also cannot come to the OAH by themselves. Though he considers all such world attachments as 'Maya' (illusion) yet acknowledges that it is very difficult to get over it.

On the contrary, the newly joined residents were in their transition phase and are yet to develop their social circle in the OAH. Nonetheless, as their memories of familial discordance are fresh in their minds, the newly joined elderly develop a sense of detachment from their families and devote themselves to spirituality. As Mr. Vijendra shared his experience:

I liked this OAH from day one. I live here with dignity, and I don't want to leave this place. ...I don't want even a straw of support from my family members. Although the children have to serve their aged parents, they rarely fulfill this duty. Gone are those days when aged parents received care and support from their children. So, even if my sons come to take me home, I will refuse. I will live here till my last breath.

Mr. Jai Prakash Singh, the manager of Vridhjan Awas, underlined that the OAH offered basic amenities (like a bed, fan, common television, safe drinking water, clean accommodation, regular medical check-ups, etc.) to the elderly. However, since inmates visit the OAH for penance, it does not offer luxuries like an air conditioner, washing machine, television, or refrigerator in personal rooms.

Apart from offering food, clothing, and daily necessities to the elderly free of cost, both the OAHs arranged many cultural events.

Thus, all festivals were celebrated on the premises of the institute. Besides, the management celebrates the birthdays and wedding anniversaries of the inmates and on such occasions, sweets, cakes, and food are distributed. The OAHs also have television for the entertainment of the inmates and there are also provisions for indoor games like ludo, carom, and playing cards. In Vridhjan Awas, for the health check-up of the residents, a physician regularly visits the OAH and in case of a medical emergency, the patient is shifted to the nearby government hospital. The OAH of Missionaries of Charity has a residential doctor and also offered regular counseling services to its inmates.

Most of the inmates engaged in an active lifestyle in the OAHs. The day of the residents typically began with physical exercise and yoga. After the morning chores, the inmates engaged in worship and prayer. Breakfast is served at 7:00 am, following which inmates engage in reading newspapers, friendly discussions, and exchanging views on various socio-political happenings in the country. Some of the inmates take a stroll in the premises, while others involve themselves in gardening or voluntary help the staff in preparing the lunch (e.g., washing and chopping vegetables, suggesting new recipes and instructing the cooks, etc.). Lunch is served at noon and most elderly take a rest after having lunch. Evening tea is served at 4:00 pm and it is followed by 'aarti'/'bhajan kirtan' at 6:00 pm. The inmates immersed themselves in spirituality in an attempt to forget their pain and suffering. Dinner is served at 8:00 pm.

In Vridhjan Awas, it was also found that inmates were given various administrative responsibilities that helped in the smooth functioning of the OAH. Thus, there are various administrative committees in the institution and every inmate was made a part of such committees. Thus, in disposing of the responsibilities of the chairman, vice-chairman, or members of various committees, the inmates develop a sense of belonging and involvement in the administrative affairs of the OAHs. For instance, Mr. Ravindra Pandey shared his daily routine at OAH in the following words:

I wake up early in the morning and make yoga arrangements for all the inmates. Every inmate has been given some responsibility and I have been given the responsibility of organizing yoga sessions every morning. Others have been given responsibilities like helping in cooking, maintaining cleanliness, upholding security, etc. All the residents have been discharging their assigned responsibilities with utmost sincerity.

Similarly, another resident, Ms. Aruni Ghosh, described her responsibilities in the following manner:

When I joined this OAH, I voluntarily engaged myself in activities like chopping vegetables and monitoring the cooking. I gradually disengaged myself as my health deteriorated.

Mr. Jai Prakash Singh, the manager of Vridhjan Awas, explained that such responsibilities not only help maintain the physical and mental health of the elderly by keeping them preoccupied but also enhance their self-esteem. It gives them the feeling that they are earning their living. A few inmates also engaged themselves in making handicraft products like flower garland making, tulsi bead making, pickle making, etc. as a way of earning a small income. However, engagement with such activities is voluntary and never enforced by OAH. As Mr. Singh elucidated:

The idea is to keep the elderly engaged. Moreover, it is an attempt to convince them that they are earning their food and not living on charity. Apart from the responsibilities, the elderly are also given the option to earn small incomes by engaging themselves in various crafts like flower garland making, tulsi bead making, pickle and marmalade making, cotton wick making, etc. Their time is well spent, and they also have some money for personal expenses.

Moreover, the elderly are also given every option to pursue their interest/preoccupation in the OAH. Ms. Meena Basu, for instance, explained:

I have the habit of reading the daily newspaper. It keeps me abreast of the happenings around the world. I still do that here. I am also very fond of reading books and still keep reading them. I also regularly participate in the morning prayers and daily 'aarti' (religious rituals).

Thus, their new roles gave new meanings to their lives and they engaged in pastimes like worshipping, meditation, devotional service (like singing 'bhajan'), kitchen activities, physical exercise, yoga, walking, visiting or talking to friends, watching soap operas on the TV, gossiping over tea, involvement in mess committee, reading newspapers and magazines, participating in the festivals and events, etc. While the inmates were living out their *karma*, such engagements were found to kindle sparks of happiness in their mundane lives.

Echoing Dotterweich (2018), we found that many of the inmates referred to the service that they received in the OAH as 'seva' (service). In other words, the staff was substituting the children in offering services to the elderly. Such 'seva' (service) included cleaning rooms, helping them with their ailments and disabilities, accompanying them for a stroll, taking them to physicians, cleaning clothes and utensils, running errands, etc. It was found that a familial relationship emerged among the residents and staff. The administrative staff commonly addressed the residents as "Mother," "Father," "Uncle," or "Auntie". However, the social life in the OAHs is disrupted at the demise of an inmate. As Mr. Tribhuvan observed:

We are like a family here and become very fond of each other over the years. We become a little sad when someone dies. But we console ourselves by thinking that he/she has attained moksha. And this is life, we must move on.

Conclusion

This paper explored the dynamics of relocation to the free OAHs of Varanasi. It was found that the elderly shifted because of factors

like misfortune and death, familial discord, economic hardship, loneliness, etc. Moving beyond the repeated narrative, it was found that their movement to OAH in Varanasi was involuntary and not happened out of their volition. The inmates generally considered it their misfortune that they are forced to spend the last days of their lives in OAHs rather than with their families. The inmates used the Hindu philosophy of 'Karma' to justify and give meaning to their current conditions and interpreted their sufferings as a way of paying off 'karmic' debts for attaining 'moksha'. This underlines the persistent functionality of religious philosophy in tiding over the crisis and struggles in life. It was found that the management assigned each inmate certain responsibilities like helping in cooking, yoga session organizing, maintaining the cleanliness of the premises, upholding security at OAH, etc. Further, they were given the option of earning a small income by selling various handicraft items (e.g. flower garlands, tulsi beads, cotton wick making, pickle making, etc.). It was found that engagement with such activities helped in the enhancement of self-esteem and countering boredom among the inmates. The inmates also formed their social circle in the OAHs. The fact that they were in similar situations and were in pursuit of the same goal, made them form a supportive social milieu. Moreover, the inmates also entered into ties with the staff of the OAH, and help/services received from the caregivers were perceived as receiving 'seva' from their 'surrogate' children. Ironically, such an act of building and sustaining relationships stands against the philosophy of moving beyond the world of 'maya' (attachment) in pursuit of 'moksha'. Thus, while the elderly steadily traversed the path of liberation through penance, they could not overlook the social emotionality in their mundane lives.

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References

- Chand, D., & Chatterjee, S. C. (2019). Problematics of caring in a spiritual gerontopolis: A study of old age homes in Varanasi (Kashi). *Journal of Religion, Spirituality & Aging*, 32(2), 188–205.
- Dotterweich, L. (2018). “We are not only here to die” – living in a spiritual old age home in Varanasi (India). *German Anthropology Online*, 8(01), 1–22.
- Jamuna, D. (1999). Elder care in India. Conflicting tradition and modernization. Ageing societies in a new millennium. *Proceedings of 3rd International Conference of IAHSa*, pp. 33–35.
- Kalavar, J. M., & Jamuna, D. (2008). Interpersonal relationships of elderly in selected old age homes in Urban India. *Interpersona: An International Journal on Personal Relationships*, 2(2), 193–215.
- Lamb, S. (2013). In/dependence, intergenerational uncertainty, and the ambivalent state: Perceptions of old age security in India. *South Asia: Journal of South Asian Studies*, 36(1), 65–78.
- Mishra, A. J. (2008). A Study of the Family Linkage of the Old Age Home Residents of Orissa. *Indian Journal of Gerontology*, Vol 22(2). Pp. 196–212.
- Rajan, S. I. (2002). Home away from home. *Journal of Housing For the Elderly*, 16(1–2), 125–150.

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A North-South Comparative Study of Factors Affecting the Living Arrangements of Elderly in India : An Analysis from LASI wave 1, Survey (2017-18).

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ABSTRACT

The living arrangement of senior citizens in India is an important concern because of the increasing cohort of the older population. The purpose of this comparative study was to understand the factors affecting the living arrangements of 4356 elderlies (60+) living in northern states and southern states of India. The study is based on LASI Wave-1 Survey of India, conducted in 2017-18. Bivariate and multinomial logistic regression was used to understand the association between the elderly living arrangements and other variables. It was found that nearly 11.8 percent from southern states and 2.2 percent from northern states aged 60+ elderly living alone in India. Elderly with financial support, have self-income, receive social benefits and belong to wealthy families live separately. There is a need for decentralised policies for the aged people's health and well-being.

Keyword – Living arrangement, Elderly, Widow, Health, LASI.

The world continues to experience a persistent change in the population's age structure, driven by increasing life expectancy and decreasing fertility levels. People live longer lives, and both the share

and the number of older people in the total population are growing rapidly. Population ageing is occurring everywhere: nearly every country in the world is experiencing a substantial increase in the size and the proportion of the population aged 65 years or over. Globally, there were 727 million persons aged 65 years or over in the world in 2020. Over the next three decades, the global number of older persons is projected to more than double, reaching over 1.5 billion in 2050 (World Population Ageing, 2020). the share of the population aged 65 years or over is projected to increase from 9 per cent in 2020 to 16 per cent by 2050 and 28 per cent by the end of the twenty-first century (United Nations, 2019). Population ageing is occurring along with broader social and economic changes that are taking place around the world: The decline in fertility, changes in patterns of marriage, cohabitation and divorce, increasing incomes and levels of education, progress towards gender equality, and the empowerment of women, improvements in public health, including access to sexual and reproductive health care, and medical technologies, as well as globalisation, urbanisation and migration reshape the context in which older persons live, including the size and composition of their households and their living arrangements. Many of these changes raise concerns about a possible weakening of the traditional family, which historically has been the foundation of economic security and social support for older persons in many parts of the world (Department of Economic and Social Affairs, 2017). At the global level in the year 2010, women and men aged 65 years or over were about equally likely to live independently. 43 percent of older women and 45 per cent of men live independently.

Among them there was a significant gender gap in the proportion residing one-fifth of women lived alone compared to 10 per cent of older men (Kamiya, Hertog, Bravo, Kisambira, & Schmid, 2020). There is great diversity across countries and regions of older people co-residing with their children. The proportion of older persons living with at least one of their children ranged from

a high of 94 per cent in Afghanistan to a low of 9.6 per cent in Switzerland. In most Asian countries in general and in particular, the elderly was considered an asset in a family structure wherein they were ensured familial care and support. But nowadays, the prevalence of older persons living in nuclear households is increasing, and living in extended family households has been declining. All over the world, China and India have one-third of the world's 60 and above population (United Nations, 2017). In India, the share of the elder people is expected to increase by more than double from 10 crores in 2011 to 23 crores in 2036, a total increase in total population from 8.4 to 15.0 per cent (MHFW, 2019). Data from the NSSO 75th round found that in India 6.6 per cent of elderly females and males live alone, and 27.5 per cent aged 80 years and above are immobile. 50 per cent of males and 90 per cent of females are financially dependent on others and more so in poorer economic quintiles (Ranjan & R, 2020). Similarly, a recent study (Muhammad, *et al.*, 2021) found that nearly 21 per cent of older adults were living alone/with a spouse. Oldest-old (>80 years) men had a higher probability of preferring living separate than the young-old (60-80 years) age group.

A living arrangement in India: The family has been the main social security for senior citizens in India. Most of the senior citizens reside with their children. The Joint family system, in a country like India, ensured that the needs of the elderly were taken care of, at the point of life where they were unable to look after themselves, both physically and financially. However, over the years joint families are decreasing and nuclear families are taking their place, breaking the family system and weakening the family's ties. (Krishnaswamy *et al.*, 2008). In a country like India, where mortality and fertility reduction due to improvements in medical technology, indicate that in the future there will be fewer children to care for but more elderly. Further, migration for employment means fewer children are living with their parents for the job, this resulting in the elderly having to care for themselves

or in the company of caretaker will lead to institutionalisation of living among the elderly. The high cost of living and shortage of living space in urban areas further left no choice but to leave their parents behind in the rural area (Jadhav, Sathyanarayana, and, Sanjay Kumar, 2013). Nowadays lack of privacy is cited as an important disadvantage of living together. But on the other hand, when women work outside the home childcare can be a problem. This situation can increase co-residence given that an elderly parent at home takes care of the home and children. Also the love and care by family members especially grandchildren prevented the aged from feeling isolated and lonely (Asis, Domingo, Knodel, & Mehta, 1995). Reversely, it was found that women who are a caregiver in the family, are no longer home-bound. This has caused major problems for the elderly in terms of social care. After a certain period, the young generation spent their time and money on their children rather than the elderly, who are also in need of the same care. This will lead to conflict in the family (Kumar, 1999). Young adults when they move to the cities or abroad and leave elderly parents at home could potentially lead to a reduction in co-residence. Sometimes it is also happening that migration of adult children makes their parents more financially secure because of remittances sent to them (Bongaarts & Zimmer, 2002).

Elderly people with more frequent social participation prefer independent living arrangements. This may be because they have more sources for social support or do not want to disturb children's life (Chen & Chen, 2012). In India, living arrangement is affected by many factors among them gender, marital status, education level, place of residence, family support, employment status, contribution to the household income, a victim of violence, presence of grandchildren, internal and international migration, cultural norms, life expectancy; monthly consumption expenditure play a major role (Ali, 2016; Muhammad, Balachandran, & Srivastava, 2021; Samanta, Chen, & Vanneman, 2015; United Nations Department of Economic and Social Affairs, 2005). Changes in the living arrangement also

affect the subjective well-being of the elderly in India. Older individuals who lived with children, had higher educational status, a better household wealth index, and reputed community involvement had significantly higher levels of subjective well-being than their counterparts. (Muhammad, and Srivastava, 2021). It is also found older adults living with their spouses and children report more depressive symptoms than those living alone (Chauhan, Kumar, & Patel, 2021).

A recently conducted survey Longitudinal ageing study in India on the elderly found that in India, 27percent are children (age 0-14 years), 61 percent are the working-age population (age 15-59 years), and 12percent are the elderly age (60 and above). The percentage of elderly age (60+) is highest in the states of Kerala (20%) followed by Himachal Pradesh (17%), Tamil Nadu (16%) Puducherry (16%), Goa (15%) , and Punjab (14%) (National Programme for Health Care of Elderly- LASI, 2020). India is still characterised by its traditional ways of living together in a household. Due to improved health infrastructure and increased life expectancy, nowadays elders are expected to live longer. But now the joint family system is on the decline and nuclear family arrangements are coming into existence. Aside from this, the Indian elderly are facing several other challenges, such as lack of sufficient income to support themselves, absence of total social security, loss of social status, and non-availability of an adequate health care system (Panigrahi, 2010). Living alone often increases vulnerability to health and economic burden (Arokiasamy, Bloom, Lee, Feeney, & Ozolins, 2011). Elderly living alone are significantly more likely to suffer from chronic as well as acute ailments than those living with family (Agrawal, 2012a). In the Indian scenario, the choice to live alone is often not the older adult's decision and could be the result of being vulnerable and socially rejected by family and others (Ugargol, Hutter, James, & Bailey, 2016). This study will add some more results to the current literature such as, is there any differential in factors affecting the living arrangement of the elderly

by the north-south divide. Hence, two northern states (Punjab and Himachal Pradesh) and two southern states (Tamil Nadu and Kerala) are taken for the comparison purpose as the percentage of the elderly population is high in these states at the National level.

Methods and Materials

The present research is based on the analysis of available secondary data from the survey Longitudinal ageing study in India wave one (LASI Wave-1) conducted in 2017-18. LASI is the first-ever survey in India that provides in-depth information on ageing, social relationship, family, life satisfaction, social support, and views of ageing adults in the light of changing social and familial events. The target population for the LASI wave 1 includes older adults and women aged 45 years and above; however, only 60 years and above are included in this study. The LASI covered a panel sample of 72,250 individuals aged 45 and above. This study concerns subjects aged 60 years and above, and in this age range, the sample included 4368 individuals from the above-mentioned four States to fulfill the targeted objectives of the study.

Variable description:

Outcome variable. The outcome variable is a ternary classification of the living arrangement. It was formed using the question– ‘What is your preferred living arrangement?’, which had responses of ‘alone’, ‘with spouse only’, ‘with sons’, ‘with daughters’, ‘either sons or daughters’, ‘with other relatives’, ‘in an old age home’ and ‘other’. It was then recorded as 3, for responses of ‘with sons’, ‘with daughters’, ‘either sons or daughters’, ‘with other relatives’ and ‘2’ for ‘with spouse and others’, and ‘1’ for ‘alone only’. For the analysis purpose, we have only taken the living alone category.

Socio-Economic/ Background related variables: Age categorized as 60–79 and 80+, sex was categorized as male and female, marital status was categorised as currently married, widow and others, educational status was categorized as no education,

primary, matriculation, 12 and above, religion was categorised as Hindu, Muslim and others. Caste was categorized as Scheduled Caste/Scheduled Tribe, Other Backward Class, and none of them), Wealth Index as Poor middle and rich, working status as Yes and No., the residence is categorized as rural and urban, receiving any Financial Support from anyone in the family (Yes/No), Having any social benefit such as old age pension, widow pension, etc. (Yes/No), Having any asset such as any health insurance or any other scheme (Yes/No), Individual income as no income, central Government Pension, State government Pension, Other pension schemes, whether having any income from agriculture (Yes/No).

Morbidity related variables: Having any Physical or mental disability (Yes/No), troublesome problems related to joints, ankles, short breathing, dim light, back pain, headaches, exhaustion, chest sound while breathing, and cough) in the past two years (Yes/ No), Self-rated health (SRH) is categorized as (good, fair, poor, and don't know), Satisfied with life (Disagree, neither agree nor disagree, agree and don't know), Any type of ill-treatment in last year (Yes/No), Difficulty in taking medication (Yes/ No), Difficulty in using the toilet (Yes/No).

Statistical analysis: Univariate, Bivariate, and Multivariate analyses have been used to show the factors effecting the living arrangement of the elderly population in the north and south region of India. Bivariate analysis is done along with the Chi-square test to show the association of dependent and independent variables. Since the variable living arrangement is the categorical dependent variable in nature with more than two unordered or nominal values i.e., living alone, living with spouse and others, and living with children and others, the multinomial logistic regression (MLR) is used to understand the effect of each independent variables on the dependent variable by using the odds ratio in STATA-15.0 software. Living with children and others is taken as the base outcome concerning living alone and living with spouse and others,

and the interpretation is focussed on living alone elderly population for analysis purpose, the study showed the result of living alone only in the result section.

Result

Table 1 represents the living arrangements of elderly above age 60 in India. In both regions more than 50 percent elderly living with their spouse and others. i.e., (62.2 percent) in northern states and (52.7 percent) in southern states respectively. Around 12 percent of the elderly in southern states are living alone in comparison to only 2.2 percent of the elderly in northern states.

Table 1:
Percentage of elderly above 60 by living arrangement in India LASI wave 1

Living Arrangement	Northern states	Southern States
Living Alone	2.2	11.8
Living with spouse and others	62.2	52.7
Living with children and others	35.6	35.5
Sample	1625	2731

Table 2 represents the socio-economic profile of older adults who are living alone in India. In comparison to northern states, more males (5%) and females (17%) are living alone, in southern states. In northern states divorced and separated are more in category of living alone but when we see in southern states, we found that widows are mostly living alone i.e., one-fourth (26%) of the total elderly population. Further, we found that in the level of education, uneducated elderly (18.6%) of southern states mostly live alone, but it is completely reverse in the case of northern states. Here elderly who have an education of 12 and above (9.1%) are more living alone. There is no difference among the religion of northern states but in southern states, it is revealed that (13%) of the elderly who belong to the Hindu religion are living alone, in comparison to Islam (7.8%) and other religions.

When we see caste-wise we found that OBC (4.5%) elderly more living alone in northern states, but it is SC/ST (13.9%) who are more living alone in southern states. Rich elderly are living alone in both regions. Working elderly (13.5%) live alone in southern states, but there is no difference in the northern states. Urban (3.3%) elderly are living more alone in northern states but in southern states, it is the rural (14.1%) elderly who are living alone. Elderly with physical or mental disability (12.3%) are living more alone in southern states, similarly elderly who are receiving financial support (18%) are living more alone in southern states but in the case of northern states the elderly who are not receiving financial support (2.2%) are living more alone. The elderly in both the regions who do not have any assets are more living alone in comparison to those who have the same. Simultaneously, the elderly without any individual or agricultural income (Northern states 2.5%, 3.1%, Southern states 12.3%, 12.1%) live mostly alone in both the regions as compared to those who have an income source.

Table 2:
Bivariate association for living alone by background characteristics among older adults in India, LASI wave 1

Background Variables		Northern states		Southern states	
		%	N(P-value)	%	N(P-value)
Sex	Male	2	806***	4.9	1190***
	Female	2.3	819	17.0	1553
Marital status	Currently Married	0.5	1029***	0.2	1463***
	Widowed	4.4	556	26.3	1075
	Others	13.5	40	17.8	204
Level of Education	No Education	1.7	858***	18.6	1033***
	Primary	2.1	507	8.1	1131
	Matriculation	1.8	183	7.2	349
	12 and above	9.1	77	6.0	230
Religion	Hindu	2.3	663*	12.9	2135***
	Islam and others	2.1	962	7.8	608

Caste	Sc/St	1.2	605*	13.9	368***
	OBC	4.5	306	12.5	1957
	None of them	1.9	714	6.4	418
Wealth Index	Poor	0.7	313***	10.9	1177***
	Middle	1.4	347	12.3	544
	Rich	2.9	964	12.4	1022
Working Status	No	2.0	1283***	11.2	2064***
	Yes	2.6	342	13.5	679
Place of residence	Rural	1.7	1147*	14.1	1462***
	Urban	3.3	478	9.1	1281
Physical or mental Disability	No	2.4	423***	10.2	568***
	Yes	2.1	1202	12.3	2163
Financial Support Received?	No	2.2	1502*	10.7	2329***
	Yes	1.7	123	18.0	414
Social Benefit	No	2.4	1029***	10.0	2120***
	Old	1.3	527	16.4	500
	Widow	5.0	68	23.7	123
Assets	No	2.2	1515***	13.0	1788*
	Yes	1.4	110	9.4	955
Individual income	No	2.5	1377***	12.3	2145***
	Central	0.4	144	6.7	113
	State	0.0	76	11.3	344
	Other	0.0	28	8.3	140
Agriculture income	No	3.1	1041***	12.1	2079**
	Yes	0.4	584	10.7	664

Results from MLR shown in table 3 suggest that compared with elderly widows, elderly who belong to another category (Divorced/ Separated) in northern states have higher chances (1.46, $p < 0.05$), whereas in southern states they have lower chances (-0.54, $p < 0.005$) to live alone. Concerning primary educated elderly in both the regions, the elderly of northern states with 12 and above educational level (2.10, $p < 0.005$) and elderly of southern states with no education (0.41, $p < 0.005$) and with matriculation (0.73, $p < 0.001$) have higher chances to live alone. Elderly of southern states who belong to Islam or other religion (-0.31, $p < 0.05$) and are not reserved caste (-0.51,

$p < 0.005$) have lower chances to live alone whereas the elderly of the northern region, concerning OBC category other caste categories have lower chances to live alone. In the case of wealth index and working status, the rich working elderly in northern (2.40, $p < 0.001$; 1.84, $p < 0.001$) as well as southern regions (0.45, $p < 0.001$; 0.96, $p < 0.001$) have higher chances to live alone whereas the urban elderly of southern states (-0.59, $p < 0.001$) have lower chances to live alone in comparison to their northern counterparts. Elderly in the southern region who receive financial support (0.96, $p < 0.001$) and have the social benefit of the old pension scheme (0.28, $p < 0.05$) have higher chances to live alone. Elderly in southern states having assets and agricultural income have lower chances to live alone whereas in the case of northern states elderly having agriculture income have lower chances to live alone.

Table 3

Multinomial logistic regression estimates for living alone by background characteristics among older adults in India, LASI wave 1

Background Characteristics		Northern States	Southern States
		(CI 95%)	(CI 95%)
Sex	Male®		
	Female	-0.19(-1.20,0.80)	0.17(-0.24,0.59)
Marital status	Widowed®		
	Currently Married	1.10(-0.58,2.79)	0.83(-0.51,2.16)
	Others	1.46**(-0.05,2.98)	-0.54**(-1.01,-.07)
Level of Education	Primary®		
	No education	0.21(-0.81,1.24)	0.41**(-0.60,0.77)
	Matriculation	0.54(-1.26,2.34)	0.73***(-0.21,1.24)
	12 and above	2.10**(-0.29,3.92)	0.36(-0.31,1.04)
Religion	Hindu®		
	Islam and others	-0.31(-1.22,0.60)	-0.31*(-0.71,0.09)
Caste	OBC®		
	SC/ST	-1.17*(-2.40,0.06)	0.06(-0.34,0.46)
	None of them	-1.21**(-2.28,-0.013)	-0.51**(-0.99,-0.03)

Wealth Index	Poor®		
	Middle	0.46(-1.43,2.36)	0.04(-0.37,0.45)
	Rich	2.40*** (0.81,3.99)	0.45*** (0.11,0.78)
Working Status	No®		
	Yes	1.84*** (0.75,2.91)	0.96*** (0.58,1.34)
Place of residence	Rural®		
	Urban	0.25(-0.81,1.31)	-0.59*** (-0.91, -0.28)
Physical or mental Disability	No®		
	Yes	0.47(-0.64,1.58)	-0.07(-0.46,0.33)
Financial Support Received?	No®		
	Yes	0.08(-1.20,1.36)	0.96*** (0.6,1.32)
Social Benefit	No®		
	Old	-0.47 (-1.50,0.56)	0.28* (-0.08,0.65)
	Widow	0.63(-0.62,1.89)	0.21(-0.27, 0.69)
Assets	No®		
	Yes	0.72 (-0.88,1.01)	-0.40** (-0.73, -0.07)
Individual income	State®		
	No	18.79(17.62,11.07)	(-0.1(-0.56,0.36)
	Central	17.66(11.49,11.95)	-0.03 (-0.95,0.89)
	Other	3.39(-19.84,19.63)	-0.23(-1.02,0.57)
Agriculture income	No®		
	Yes	-2.32*** (-3.69, -0.94)	-0.35* (-0.76,0.06)

In this table four, we have found morbidity status among elderly who are living alone. In northern states, we found that the elderly who have had troublesome problems in the past two years are living more alone in comparison to the elderly who have not any problems. Elderly with the poor self-rated health are living alone in both regions. In the northern states more elderly who disagree with the satisfaction of their life are living alone in comparison to others. Most importantly it is found that the elderly who are receiving ill-treatment in the last year are mostly living alone in both regions in comparison to those who are not receiving any ill-treatment. Again, we found that in southern states more elderly who have difficulty taking medicine are living alone as compared to their counterpart.

Similarly, the elderly having difficulty in using the toilet live more alone than the elderly having no difficulty.

Table 4
Pattern of living alone with morbidity Status among elderly in India, LASI wave 1

Morbidity Variables		Northern states		Southern states	
		Living alone	N (P-value)	Living alone	N (P-value)
Troublesome problems	No	1.6	1129*	11.9	1702*
	Yes	3.4	496	11.5	1040
Self-rated health	Good	1.9	373***	9.9	317***
	Fair	1.7	852	9.6	939
	Poor	3.6	74	13.6	1420
Satisfied with life	Disagree	5.9	218***	18.2	622***
	Neither nor	2.4	201	9.5	364
	Agree	1.5	1153	9.8	1660
Ill-treatment	Yes	7.1	30*	25.2	76***
	No	2.1	1542	11.4	2573
Difficulty in medication	Yes	2.2	186***	16.9	370***
	No	2.2	1439	11.0	2373
Difficulty in using the toilet	Yes	2.7	246***	14.9	504***
	No	2.1	1379	11.1	2239

Results from MLR shown in table 5 show the multinomial logistic regression estimates for morbidity status among elderly (60+) who are living alone region-wise. The results suggest that in comparison to the elderly population without troublesome problems in the past two years, the elderly who suffer from these problems are more prone to live alone in both regions, (Northern India : 0.86, $p < 0.005$; Southern India: (0.2, $p < 0.05$). With respect to poor self-rated health (SRH) by the elderly in northern India, elderly with good (-0.74, $p < 0.05$) or fair (-0.94, $p < 0.005$) SRH have lower chances to live alone. Elderly of both the regions who are not satisfied with life (Northern India: 1.54, $p < 0.001$; Southern India: 0.56, $p < 0.001$) are more prone to live alone than the elderly population who is satisfied with life. In the case of the elderly

population who suffered ill-treatment last year in northern states, the elderly population who didn't suffer from ill-treatment are less prone to live alone with respect to the suffering population (-2.12, $p < 0.005$). The elderly of northern states having no difficulty in taking medication are more prone to live alone concerning their counterparts (1.24, $p < 0.05$).

Table 5

Multinomial logistic regression estimates for morbidity status among elderly who are living alone in India, LASI wave 1

Morbidity Variables		Living alone	
		Northern states	Southern states
Troublesome problems (in the past 2 yrs)	No ®		
	Yes	0.86**(0.05,1.67)	0.2*(-0.09,0.50)
Self-rated health	Good	-0.74*(-1.84,0.36)	-0.11(-0.60,0.38)
	Fair	-0.94**(-1.82,-0.08)	-0.07(-0.38,0.25)
	Poor®		
	DKR	1.26(-2.08,4.61)	0.18(-1.54,1.93)
Satisfied with life	Disagree	1.54*** (0.70,2.39)	0.56*** (0.24,0.88)
	Neither nor	0.68(-0.48,1.84)	-0.06(-0.51,0.39)
	Agree®		
	DKR	-2.64(-6.23,0.94)	1.03(-0.79,2.85)
Ill-treatment (last year)	Yes ®		
	No	-2.12**(-3.82,-0.42)	-0.41(-1.04,0.22)
	DKR	-	-2.05*(-4.5,0.40)
Difficulty in taking medication	Yes®		
	No	1.24*(-0.16,2.64)	0.22(-0.19,0.63)
Difficulty in using a toilet	Yes ®		
	No	-0.03(-1.17,1.11)	0.14(-0.23,0.50)

Discussion

Currently, 727 million persons are there with age more than 65 years in the world. In the coming three decades it was projected that the global number of older adults will go more than double, reaching over 1.5 billion in 2050 (World population ageing 2020). The decline in fertility, changes in marriage, cohabitation, and divorce patterns,

rising incomes and levels of education, progress toward gender equality and women's empowerment, as well as globalisation, urbanisation, and migration, are all contributing to population ageing around the world. Many of these changes raise a concern about a possible weakening of traditional family norms, including the size and composition of their households and their living arrangements (Department of Economic and Social Affairs, 2017). In 2010, women and men aged more than 65 years were likely to live alone on a global scale. 43 percent of older women and 45 percent of older males are self-sufficient. There was a considerable gender discrepancy in the proportion of people living alone among them: one-fifth of women lived alone compared to 10 per cent of older men (Kamiya *et al.*, 2020).

The current study is based on secondary data from the Longitudinal Ageing Study in India wave one (LASI Wave-1) survey, which was performed in 2017-18. LASI is the first survey of its kind in India, providing detailed information on ageing, social relationships, family, life satisfaction, social support, and the perspectives of ageing individuals in the context of changing social and familial events. The LASI wave 1 target group comprises older people and women aged 45 and above; however, only those aged 60 and up are included in this study. A panel of 72,250 people aged 45 and up participated in the LASI. This study focused on those aged 60 and up, and the sample included 4368 people in this age range. We found in our analysis that more elderly live alone in southern states in comparison to northern states. Similarly, Arokiasmy, *et al.*, (2011) found that living alone is more common in the southern states of Kerala and Karnataka and least common in Rajasthan. It may be because of larger family support and more intergenerational bond. One more explanation is that in southern states due to the migration of adult children, older adults may be more financially secure because of remittances received from their children.

Widows are living mainly alone in southern states it may be women experience a higher risk of death of a spouse because men

are usually older than their wives and have higher age-specific death than women. Therefore, the probability of living alone is more in older women than men. (Albert & Korson, 1972; Bishop, 1986; Bongaarts & Zimmer, 2002; Jadhav *et al.*, 2013). It is found that educated elderly living more alone in northern states may be because educated people have stronger preferences for privacy that cannot be expressed by the least educated. One more explanation is that where education is lower older adults own fewer resources. They are therefore more dependent on adult children for their basic needs. (Bongaarts, and Zimmer, 2002; Lai, 2005; Panigrahi, 2009; Chen, and Chen, 2012; Mutchler, *et al.*, 2017;). but it is the opposite in the case of southern states here, with uneducated elderly living alone. (Jadhav *et al.*, 2013; Muhammad & Srivastava, 2020) Muhammad, and Srivastava, (2020); (Jadhav *et al.*, 2013) also found that the elderly with a higher level of education have more chance of moving among their children. Hindu and lower caste elderly mostly live alone.

Our study found that wealth is positively related to living independently among the elderly of both regions. It may be elderly with better socioeconomic conditions prefer living alone (Bishop, 1986; Panigrahi, 2009; Chen, and Chen, 2012;). Working elderly living alone in southern states as the previous literature also suggest that individual who report working in the last years are more likely to live alone and spend money on healthcare. Due to greater earning power, they are better able to care for themselves because they are in better health and can live independently (Bongaarts, and Zimmer, 2002; Arokiasamy, *et al.*, 2011;). Urban elderly (Jadhav *et al.*, 2013) in northern states and rural elderly in southern states are living more alone.

Urban elderly living more alone may be on account of the time spent by working members of the family with aged people is less because of competing commitments and lifestyle and in the rural area traditional elderly are taken care by the family and this accepted norm is also found in their preferences (Asis, *et al.*, 1995; Panigrahi, 2010). One possible explanation for southern elderly living more alone in the rural area because of migration of their children. The elderly

of northern states without financial support live more alone but in the case of southern states more elderly who receive financial support are living alone, it is because southern states get financial help from their children in form of remittances. Income is a factor that helps in living independently. Elderly with individual income are living alone in both the regions. Economic resources were seen as helping the elderly person maintain self-respect which could be eroded by becoming an economic burden on the family (Asis, *et al.*, 1995; Munsur, *et al.*, 2010).

We found that the elderly with troublesome problems live more alone in both regions. The elderly with poor self-rated health has a high chance of living alone in northern states. Notably, more elderly who report excellent or very good self-rated health live alone (Jadhav *et al.*, 2013). The need for constant elder care will conflict with the employment of the adult co-resident of the daughter-in-law if she is the one who has to provide care and has to go to work also (Asis, *et al.*, 1995; Lai, 2005; Agrawal, 2012b). Despite this, some studies also found that older adults who are living alone were more likely to report poor self-rated health in comparison to older adults who live with children and others (Muhammad, *et al.*, 2021; Srivastava & Muhammad, 2020).

The elderly who are not satisfied with life are more prone to live alone than the elderly population which is satisfied with life in both the region. It is because of elderly living alone are unable to meet their basic requirements in case of disability and chronic conditions therefore they are dissatisfied with their life (Banjare, *et al.*, 2015). Similarly, it was also found that the elderly with poor health conditions prefer not to co-reside with children in order not to be a burden (Krishnaswamy, *et al.*, 2008). The elderly who received ill-treatment are more living alone. It could be said that the abuse of the elderly happens more at home and therefore elderly want to live away from the internal conflict of the family and they are living alone (Munsur, *et al.*, 2010). The elderly having difficulty in negotiation are also living alone in comparison to others (Mutchler, *et al.*, 2017).

Conclusion

South Indian states may be moving toward a more western system of living arrangement, where more elderly are living alone. Although here uneducated, rural, SC/ST elderly are more living alone. On the other side in northern states, the picture is very different. Here educated, urban and OBC elderly are mainly living alone. We cannot go to the conclusion about why this scenario may be a cultural difference or still we need to explore it through primary studies. In the case of highly educated, functional elderly in good health we can say they live independently of familial structures by choice rather than compulsion. There is however the fact that among both the regions women, widows, disabled who depend on others from lower caste and the elderly who do not have any financial support are the most vulnerable of the survey population, they need better governmental schemes behind the backdrop of changing household structures in India. This study has led to an important policy implication that the elderly living alone should be given more care with a stronger public support system, especially for those who belong to the weaker sections of society such as women and the elderly who belong to scheduled caste or tribe categories and also for the elderly who are living alone without any financial support system and individual income. Further research is required to know more about the factors involved in the separate living arrangement among the elderly.

Limitations : As this study is based on secondary data, we cannot reach a general conclusion about the factors behind living alone. Further, this study was carried out by taking four different states which have different geographical and cultural variations. So, there may be different factors that influence the living arrangement of the elderly.

References

- Agrawal, S. (2012a). Effect of living arrangement on the health status of elderly in India: Findings from a national cross-sectional survey. *Asian Population Studies*, 8(1), 87–101. <https://doi.org/10.1080/17441730.2012.646842>

- Agrawal, S. (2012b). Effect of living arrangement on the health status of elderly in India: Findings from a national cross-sectional survey. *Asian Population Studies*, 8(1), 87–101. <https://doi.org/10.1080/17441730.2012.646842>
- Albert, C., & Korson, J. H. (1972). The widowed who live alone: An examination of social and demographic factors. *Social Forces*, 51(1), 45–53. <https://doi.org/10.1093/sf/51.1.45>
- Ali, S. S. (2016). Pattern of Living Arrangements among the Rural Elderly Muslims of West Bengal, India. *IOSR Journal of Humanities and Social Science*, 21(08), 58–65. <https://doi.org/10.9790/0837-2108075865>
- Arokiasamy, P., Bloom, D., Lee, J., Feeney, K., & Ozolins, M. (2011). Longitudinal Aging Study in India: Vision, Design, Implementation, and Some Early Results. *Program on the Global Demography of Aging, Working Pa*(82), 1–44.
- Asis, M. M. B., Domingo, L., Knodel, J., & Mehta, K. (1995). *Living arrangements in four asian countries: a comparative perspective*. 145–162.
- Banjare, P., Dwivedi, R., & Pradhan, J. (2015). Factors associated with the life satisfaction amongst the rural elderly in Odisha, India. *Health and Quality of Life Outcomes*, 13(1), 1–13. <https://doi.org/10.1186/s12955-015-0398-y>
- Bishop, C. E. (1986). Living arrangement choices of elderly singles: effects of income and disability. *Health Care Financing Review*, 7(3), 65–73.
- Bongaarts, J., & Zimmer, Z. (2002). Living arrangements of older adults in the developing world: An analysis of demographic and health survey household surveys. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, 57(3), 145–157. <https://doi.org/10.1093/geronb/57.3.S145>
- Chauhan, S., Kumar, S., & Patel, R. (2021). Does Living Arrangement Predict Urban–Rural Differential in Depressive Symptoms Among Older Adults in India? A Study Based on Longitudinal

- Ageing Study in India Survey. *Journal of Population Ageing*, (0123456789). <https://doi.org/10.1007/s12062-021-09348-0>
- Chen, Y. J., & Chen, C. Y. (2012). Living arrangement preferences of elderly people in Taiwan as affected by family resources and social participation. *Journal of Family History*, 37(4), 381–394. <https://doi.org/10.1177/0363199012440948>
- Department of Economic and Social Affairs. (2017). Living arrangements of older persons: A report on an expanded international dataset. *United Nations*, 1–50. Retrieved from <https://www.un.org/en/development/desa/population/publications/pdf/ageing/LivingArrangements.pdf>
- Jadhav, A., Sathyanarayana, K.M., & Sanjay Kumar, K. S. J. (2013). Living arrangement and its effect on older people in ageing societies IUSSP 2013 Busan, Korea. *IUSSP, 2013*, 8(1), 34.
- Kamiya, Y., Hertog, S., Bravo, J., Kisambira, S., & Schmid, K. (2020). *Population Division Measuring household and living arrangements of older persons around the world: The United Nations Database on the Households and Living Arrangements of Older Persons 2019 Sustainable Development Goals: 1, 3 and 5 * This report benefite*. Retrieved from www.un.org/development/desa/pd/.
- Krishnaswamy, B., Than Sein, U., Munodawafa, D., Varghese, C., Venkataraman, K., & Anand, L. (2008). Ageing in India. *Ageing International*, 32(4), 258–268. <https://doi.org/10.1007/s12126-008-9023-2>
- Kumar, S. V. (1999). Elderly in the changing traditional family structure: An Indian scenario. *Social Change*, 29(1–2), 77–89. <https://doi.org/10.1177/004908579902900207>
- Lai, D. W. L. (2005). Cultural factors and preferred living arrangement of aging Chinese Canadians. *Journal of Housing for the Elderly*, 19(2), 71–86. https://doi.org/10.1300/J081v19n02_05

- MHFW. (2019). *Population projections for India and states 2011-2036, Report of the technical group on population projections*. 1–268.
- Muhammad, T., Balachandran, A., & Srivastava, S. (2021). Socio-economic and health determinants of preference for separate living among older adults: A cross-sectional study in India. *PLoS ONE*, 16(4 April), 1–14. <https://doi.org/10.1371/journal.pone.0249828>
- Muhammad, T., & Srivastava, S. (2020). Why Rotational Living Is Bad for Older Adults? Evidence from a Cross-Sectional Study in India. *Journal of Population Ageing*, 1. <https://doi.org/10.1007/s12062-020-09312-4>
- Munsur, A. M., Tareque, M. I., & Rahman, K. M. M. (2010). Determinants of living arrangements, health status and abuse among elderly women: A study of rural Naogaon district, Bangladesh. *Journal of International Women's Studies*, 11(4), 162–176.
- Mutchler, J. E., Lyu, J., Xu, P., & Burr, J. A. (2017). Is Cost of Living Related to Living Alone Among Older Persons? Evidence From the Elder Economic Security Standard Index. *Journal of Family Issues*, 38(17), 2495–2511. <https://doi.org/10.1177/0192513X15606773>
- Panigrahi, A. K. (2010). Determinants of living arrangements of elderly in Orissa, India: An analysis. *Asia-Pacific Population Journal*, 25(2), 97–131. <https://doi.org/10.18356/3a258644-en>
- Panigrahi, Akshaya Kumar. (2009). Living Arrangements Preferences of Elderly: Evidence from Field Study in Orissa. *Indian Journal of Gerontology*, 23(4), 478–499. Retrieved from <https://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=47324875&site=ehost-live&scope=site>
- Ranjan, A., & R, M. (2020). *Equity and Elderly Health in India: Reflections from 75th Round National Sample Survey, 2017-18, amidst the COVID-19 Pandemic*. 7, 1–16. <https://doi.org/10.21203/rs.3.rs-41285/v1>

- Samanta, T., Chen, F., & Vanneman, R. (2015). Living Arrangements and Health of Older Adults in India. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, 70(6), 937–947. <https://doi.org/10.1093/geronb/gbu164>
- Srivastava, S., & Muhammad, T. (2020). Violence and associated health outcomes among older adults in India: A gendered perspective. *SSM - Population Health*, 12, 100702. <https://doi.org/10.1016/j.ssmph.2020.100702>
- Ugargol, A. P., Hutter, I., James, K. S., & Bailey, A. (2016). Care Needs and Caregivers: Associations and Effects of Living Arrangements on Caregiving to Older Adults in India. *Ageing International*, 41(2), 193–213. <https://doi.org/10.1007/s12126-016-9243-9>
- United Nations. (2019). World population ageing, 2019/ : In *World population ageing 2019*. Retrieved from <https://digitallibrary.un.org/record/3846855>
- United Nations, 2017. (2017). *World-Population-Prospects-the-2017-Revision @ Www.Un.Org*. Retrieved from <https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html>
- United Nations Department of Economic and Social Affairs. (2005). Living Arrangements Patterns and Trends. *Living Arrangements of Older Persons around the World*, 15–61.
- World Population Ageing, 2020. (2020). World Population Ageing. In *Economic and Social Affairs United Nations*. Retrieved from http://link.springer.com/chapter/10.1007/978-94-007-5204-7_6

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