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Association between physical activity and cognitive function among community-dwelling older adults in Delhi NCR: a cross-sectional study

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ABSTRACT

Age-associated decline in physical and cognitive functioning is one of the most significant health problems associated with healthy ageing. This study aimed to evaluate the association between physical activity (PA) level and cognitive functioning among the older Indian population residing in Delhi-National Capital Region (NCR), India. A cross-sectional study was conducted among community-dwelling adults aged 50-65 years using the International Physical Activity Questionnaire-Short Form (IPAQ-SF) and Montreal Cognitive Assessment (MoCA). The total number of respondents was 400 (mean age: 56.3 ± 5.8 years), with 67% female and 33% male. 70% of respondents were moderately active, with a mean MoCA score of 21.3 ± 3.8 and 77% had mild cognitive impairment. There was a significant positive correlation ($r = .32$, $p < .01$) between physical activity and cognitive function, with higher activity levels resulting in better MoCA scores. Older adults' physical activity remains below WHO guidelines, highlighting the need for regular activity to maintain cognitive health.

Keywords: physical activity; cognitive function; older adults; ageing

1. Introduction

India's rapidly evolving demographics have produced increased longevity, resulting in an ageing of its population. By 2050, 22% of the world population is expected to be 60 years or older (United Nations, 2020). India is already undergoing a demographic transition where its ageing population is set to grow from 104 million in 2011 to 319 million by 2050 (Census of India 2011) (United Nations Population Division, 2019). This will present a public health challenge, especially in maintaining optimal cognitive health throughout old age.

One of the most debilitating aspects of ageing in any society is cognitive decline, characterised by a reduction in various functions, ranging from memory and reasoning to processing speed, executive functioning and overall functional independence (Murman, 2015). There are varying reports on cognitive decline prevalence among Indian older adults ranging from 14 to 41%, depending on the assessment tool used and locality (Dias & Patel, 2009). Consequently, it has become important to identify and prevent the development of cognitive impairment, which also poses issues related to healthcare resource utilization.

PA is recognized as one of the highly modifiable lifestyle choices that prevent cognitive decline in older adults (Colcombe & Kramer, 2003; Erickson et al., 2011). Regular PA has been shown to support neuroplasticity, improve blood flow to the brain, enhance the size of the hippocampus and suppress neuroinflammation which ultimately protects cognitive functioning (Voss et al., 2013; Northey et al., 2018). Both aerobic and resistance training have beneficial effects on specific cognitive processes such as executive functioning, memory and processing speed (Smith et al., 2010; Liu-Ambrose et al., 2010).

Despite robust evidence of this link between PA and cognitive function from high-income countries, research in low and middle-income countries remains limited. There are only a few Indian studies, and almost all of these are from urban Southern India, while the Northern population has not been studied adequately (Dey et al., 2001; Kumar et al., 2022). Factors like differing living practices, cultural practices, socioeconomic background and environmental surroundings are varied across India and may modulate PA and cognitive functioning.

Therefore, it was important to study the association of PA levels with cognitive functioning among older adults living in community settings in the urban region of Delhi NCR, India. Findings from this study could help to develop culturally appropriate programs that would promote healthy cognitive ageing for the Indian older population.

2. Methods

2.1 Study design and setting

This cross-sectional observational study was conducted among community-dwelling older adults residing in Delhi-NCR, India. This region is among the largest metropolitan areas of India and contains varied socioeconomic parameters and lifestyle habits making it appropriate for studies addressing PA and cognition in older adults.

2.2 Participants and sampling

A total of 400 participants were approached by convenience sampling from residential communities, community centres and senior citizen clubs located in different parts of Delhi-NCR for recruitment in this study.

Inclusion criteria: 1) All community-dwelling older adults aged 50-65 years, 2) ability to walk independently without any support, 3) absence of any diagnosed musculoskeletal, neurological, cardiopulmonary or psychiatric disorder, based on self-reported clinical diagnosis and medical/medication history obtained during the interview, 4) no recent hospital admissions in the last 3 months and 5) willing to give written consent to participate. Exclusion Criteria: 1) known clinical diagnosis of dementia or other major neurocognitive disorders, 2) poor vision and/or hearing impairment that prevents the assessments, 3) any acute medical condition that needs urgent care and 4) inability to comprehend and respond to the questions.

The World Health Organization's World Report on ageing and health points to the fact that biological ageing does not occur at a fixed chronological age, and that functional/physiological changes of ageing tend to occur earlier in low- and middle-income countries where there is often a lower cut-off used to define study populations (WHO, 2015). In keeping with this, large nationally representative Indian population studies, such as the Longitudinal Ageing Study in India (LASI) include a pre-old age cohort, where adults are followed from 45 years onwards; this is not surprising given the earlier age at onset of chronic disease, lower average life expectancy compared to high-income countries, and earlier retirement and transition of social roles predisposing them to an earlier require earlier adulthood in role transitions (International Institute for Population Sciences, 2020). We therefore opted to work with the 50-65 age band to capture this transitional, pre-senescent to early-older-adult period, which remains under-represented in the Indian physical activity-cognition literature in comparison to studies on adults aged 60 and above.

2.3 Ethical considerations

The protocol of the study was approved by the Institutional Ethics Committee of Amar Jyoti Rehabilitation and Research Centre, Delhi (Reference number: AJIRB-EC/10/2018). All participants provided written informed consent before participation after being informed about the study objectives, procedures, potential risks and benefits. All information collected and assessments conducted during the study period were kept strictly confidential with proper anonymity.

2.4 Assessment tools

Data were collected through structured personal interviews which included demographic information (age, gender, educational status, occupation, marital status and living situation). Clinical data (type of illness, duration, medication) and other lifestyle factors such as smoking habits and consumption of alcohol were also documented.

We used the IPAQ-SF for measurement of PA which is well-validated in 15–69 years population (Craig et al., 2003). The questionnaire allows the recall of the last 7 days of the subject to assess the PA under the following four categories: a) vigorous activity, b) moderate activity, c) walking and d) sitting. The information regarding frequency (days per week) and duration (minutes per day) was obtained for each type of PA.

Total PA was expressed in metabolic equivalent task minutes per week (MET -min/week) according to standard IPAQ scoring guidelines: (walking MET-min/week = 3.3 × walking minutes × walking days) + (moderate MET-min/week = 4.0 × moderate intensity activity minutes × moderate days) + (vigorous MET-min/week = 8.0 × vigorous intensity activity minutes × vigorous days). Based on the total MET-min/week, participants were classified into: Low PA (< 600 MET-min/week), Moderate PA (600-3000 MET-min/week), and High PA (> 3000 MET-min/week) (IPAQ Research Committee, 2005).

The MoCA test was used for the evaluation of the cognitive function of older adults. MoCA is widely used as an early screening instrument to assess mild cognitive impairment (Nasreddine et al., 2005). The test consists of tasks of visuospatial/executive function, naming, memory, attention, language, abstraction, delayed recall and orientation, with a maximum score of 30 points. One point was added to the MoCA test score for participants with less than 12 years of formal education. The MoCA scores greater or equal to 26 were considered normal, scores < 26 indicated a diagnosis of mild cognitive impairment, consistent with previously validated cut-off for the Indian population (Kaul et al., 2022). The MoCA demonstrated a sensitivity of 90% for MCI detection and

100% for mild Alzheimer's disease, with a specificity of 87%, and excellent test-retest reliability (Intraclass Correlation Coefficient = 0.92) (Nasreddine et al., 2005).

2.5 Data collection procedures

Data collection was done by trained research assistants who were trained in administering the IPAQ-SF and MoCA. Participants were addressed through community centers, residential welfare associations, and senior citizen groups. After completing the eligibility screening and obtaining informed consent, face-to-face interviews were done at community halls or participants' residences.

Each assessment lasted approximately 45-60 minutes. The demographic form and IPAQ-SF were administered first, followed by the MoCA assessment. All questionnaires were administered in Hindi or English based on participant preference. Data were recorded on standardized forms and then entered into electronic databases.

2.6 Statistical analysis

Data were analysed using IBM SPSS (Statistical Package for the Social Sciences) Software, version 27.0. Descriptive statistics such as frequencies, percentages, mean and standard deviation were obtained. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Normally distributed variables were reported as mean ± standard deviation, whereas non-normally distributed variables as median (interquartile range).

Independent sample t-tests were employed to compare two independent groups with normal distribution, whereas the Mann-Whitney U test was used for non-normally distributed data. One-way ANOVA (Analysis of Variance) was used to find out the difference among the cognitive function scores across three PA levels. If the ANOVA test found significant results, then post hoc Tukey's HSD tests were used. Pearson correlation coefficient was used for checking the association between PA (MET-min/week) and cognitive function (MoCA score). For all the analyses, $p < 0.05$ was considered statistically significant. Although MET-min/week showed some right-skew (as reflected in the SD relative to the mean), Pearson correlation and one-way ANOVA were retained given the sample size.

3. Results

3.1 Participant characteristics

A total of 400 community-dwelling old individuals (50-65 years, mean age 56.3 ± 5.8 years), 268 (67%) females and 132 (33%) males were enrolled. Selected demographic and clinical characteristics are described in Table 1. In terms of marital status and living arrangements, most participants were married (78%) and about 22% of participants were living alone. In terms of education, 13% were having primary education, 35% were having secondary education, 28% were having higher secondary education and 24% were possessing undergraduate degrees. More than 42% of them were retired, homemakers were 31% and 27% were employed in different occupations.

Prevalence of most common chronic conditions: 38% was hypertension, 29% diabetes mellitus, 22% arthritis and 18% dyslipidemia. More than 76% participants were on regularly prescribed medications. Among the lifestyle factors, 8% of the individuals were smokers and 12% consumed alcohol regularly.

3.2 Physical activity patterns

Table 2 shows the distribution of PA levels for the participants. Using the IPAQ-SF classification, 280 (70%) individuals were classified as having moderate activity, while 72 (18%) of the sample engaged in high levels of PA and 48 (12%) individuals had low PA levels. The overall mean value for PA was 2,240 ± 2,015 MET-min/week.

The difference in level of PA, based on sex, was statistically significant: mean total physical activity for men (2,892 ± 2,356 MET-min/week) was greater than for women (2,036 ± 2,190 MET-min/week; $p < .01$). Similarly, the level of PA decreased with higher age groups, with activity level higher in the younger age group (50-57 years) compared with older (58-65 years; $p < .01$).

Table 1. Demographic and clinical characteristics of participants (n=400)

Characteristic	N	%
Age (years), mean ± SD	56.3 ± 5.8	
Sex		
Male	132	33%
Female	268	67%
Education		
Primary	52	13%
Secondary	140	35%
Higher secondary	112	28%
Undergraduate and above	96	24%
Marital status		
Married	312	78%
Widowed/Divorced	88	22%
Living arrangement		
Living with family	368	92%
Living alone/other	32	8%
Occupation		
Retired	168	42%
Homemaker	124	31%
Employed	108	27%
Chronic conditions[a]		
Hypertension	152	38%
Diabetes	116	29%
Arthritis	88	22%
Dyslipidemia	72	18%
Medication use		
On regular medication	304	76%
Not on regular medication	96	24%
Smoking status		
Current smoker	32	8%
Non-smoker	368	92%
Alcohol use		
Regular alcohol use	48	12%
No regular alcohol use	352	88%

[a] Chronic condition categories are not mutually exclusive; participants could report more than one comorbidity (e.g., hypertension and diabetes concurrently)

Table 2. Physical activity levels by age and sex (n=400)

Variable	Category (n)	Mean ± SD (MET-min/week)	p-value[b]
Age group	50-57 years	2,547 ± 2,128	< 0.01*
	58-65 years	1,820 ± 1,842	
Sex	Male (132)	2,892 ± 2,356	< 0.01*
	Female (268)	2,036 ± 2,190	

* Statistically significant at p < 0.05. [b] Independent-samples t-test (two-group comparison); each row's p-value refers to that single comparison, not a post-hoc test

3.3 Cognitive function assessment

In all study participants, the mean MoCA score was 21.3 ± 3.8 (range: 12-29). Applying the widely used cut-off of 26, the group consisted of 308 (77%) participants with mild cognitive impairment and 92 (23%) with normal cognitive function.

As shown in Table 3, cognitive function varied significantly across various demographic subgroups. Participants with a younger age (50-57) had significantly higher MoCA scores (22.04 ± 3.57) than those with an older age (58-65) (20.34 ± 3.95, p < .01). Moreover, males performed significantly better than females on the MoCA scale (22.72 ± 3.40 versus 20.55 ± 3.83, p < .01).

Table 3. Cognitive performance by age and sex (N=400)

Variable	Category (N)	Mean ± SD (MoCA score)	p-value[b]
Age group	50-57 years	22.04 ± 3.57	< 0.01*
	58-65 years	20.34 ± 3.95	
Sex	Male (132)	22.72 ± 3.40	< 0.01*
	Female (268)	20.55 ± 3.83	

* Statistically significant at p < 0.05. [b] Independent-samples t-test (two-group comparison); each row's p-value refers to that single comparison, not a post-hoc test

3.4 Association between physical activity and cognitive function

Pearson correlation analysis revealed a significant positive association between total daily activity levels (MET-min/week) and cognitive functioning (MoCA scores; r = .32, p < .01). Significant differences were found for one-way ANOVA on cognitive performance between different levels of PA (F = 12.48, p < .01, df=2, 397), with Tukey's HSD post-hoc test indicating higher cognitive scores for high PA participants (23.18 ± 3.27) than for moderate (21.42 ± 3.62, p < .01) and low PA (19.79 ± 3.05, p < .01). The moderate level of PA resulted in significantly better cognitive performance compared with the low level of physical activity (p = .03), as presented in Table 4.

Table 4. Comparison of cognitive scores by physical activity level

Physical Activity Level	N (%)	Mean ± SD (MoCA score)	p-value
Low (< 600 MET-min/week)	48 (12%)	19.79 ± 3.05	< 0.01*
Moderate (600-3000 MET-min/week)	280 (70%)	21.42 ± 3.62	
High (> 3000 MET-min/week)	72 (18%)	23.18 ± 3.27	

Post-hoc pairwise comparison (Tukey's HSD)	Mean difference	p-value[c]
Low vs. Moderate	1.63	0.03
Low vs. High	3.39	< 0.01
Moderate vs. High	1.76	< 0.01

[c] The overall p-value refers to the omnibus one-way ANOVA across all three PA levels; pairwise post-hoc comparisons (Tukey's HSD) are reported separately below and correspond to the specific group differences

4. Discussion

This cross-sectional study examined PA level and cognitive function among 400 community-dwelling older adults residing in Delhi NCR, India. The results revealed a strong positive correlation between PA and cognitive performance, with highly physically active individuals demonstrating greater cognitive function compared to those with low PA. As this was a cross -sectional study, the causality cannot be established whether higher PA leads to better cognition or they both function together hence these findings only support PA as a modifiable risk factor for optimal maintenance of cognitive functioning in ageing populations. In the Indian context, limited research on PA and cognitive health is available so far.

The mean PA of 2,240 MET-min per week indicated that while most participants' activity levels fell in the moderate range, they remained below WHO-recommended levels of at least 150-300 minutes of moderate-intensity or 75-150 minutes of vigorous-intensity PA per week (WHO, 2020), supporting earlier evidence of PA inactivity as a significant concern among Indian older adults, particularly in urban areas (Ramamoorthy et al., 2022). Gender differences in PA were notable, with males demonstrating higher PA levels than females, a pattern common across Indian social contexts, likely attributable to cultural norms, domestic workload and limited mobility space among older women (Rajan et al., 2003). The declining PA with increasing age is consistent with established literature (Sun et al., 2013).

The high prevalence of MCI (77%) should be interpreted cautiously, as this figure appears elevated relative to international estimates of 15–20% in adults aged 65 and older (Langa & Levine, 2014). However, similar trends have been reported in other Indian studies using the MoCA, with mean scores ranging from 18 to 24, possibly attributable to educational level, cultural test adaptation and regional normative differences (Kaul et al., 2022). Age and gender differences in cognitive functioning observed here are consistent with prior documentation: ageing produces structural and functional brain changes including white matter reduction, hippocampal atrophy and synaptic loss (Murman, 2015), while gender disparities in cognition may reflect historically lower educational attainment and cognitive reserve in women (Stern, 2012).

The significant positive correlation between PA and cognitive function aligns with a robust and growing literature highlighting the cognitive benefits of PA. Meta-analyses of prospective observational studies suggest that more active individuals experience less cognitive decline and lower dementia risk in old age (Sofi et al., 2011; Blondell et al., 2014). Underlying mechanisms may include increased cerebral blood flow, elevated BDNF and neurotrophic factors in the hippocampus where neurogenesis may occur, and modulation of inflammation and oxidative stress. Structural neuroimaging studies have further associated PA

with greater preservation of gray matter volume in prefrontal and temporal regions critical for executive functioning and memory (Colcombe et al., 2006). A dose–response pattern was also evident: the most physically active participants outperformed their moderately and minimally active counterparts, consistent with findings that higher volumes of PA yield proportionately greater cognitive benefit (Northey et al., 2018).

Beyond these general mechanisms, the size of the association observed here also corresponds closely with quantitative estimates from prior research. The correlation coefficients obtained are within the range reported in systematic reviews suggesting a small to moderate PA-cognition association (Kramer & Erickson, 2007), and align with findings from large prospective studies such as the Rush Memory and Ageing Project, which associated daily PA with slower cognitive decline and reduced Alzheimer's disease risk (Buchman et al., 2012). Among the limited Indian studies available, those examining PA and cognition have found significantly better cognitive functioning across multiple domains among regularly active older adults compared to inactive peers (Kumar et al., 2022). The present study contributes to this evidence base from a Northern Indian urban setting using well-validated instruments (IPAQ-SF and MoCA), enabling cross-cultural comparisons.

The findings carry significant implications for clinical practice and public health policy in India. As the older adult population grows rapidly, identifying modifiable determinants of cognitive decline such as PA becomes critical. Healthcare providers should prioritize counselling inactive older adults, with low-cost interventions such as neighborhood walking groups, guided exercise in open spaces and senior activity clubs. Evidence for aerobic, resistance and balance training has demonstrated effectiveness in the Indian context (Tiedemann et al., 2011). Infrastructure supporting active lifestyles including pedestrian pathways, parks and elderly-friendly facilities, should be prioritized with specific strategies targeting older women who remain significantly under-participatory in PA.

The study's strengths include a large sample size, use of validated tools (IPAQ-SF and MoCA), and a focus on an underexplored urban Northern Indian older adult population. However, the cross-sectional design prevents causal inference; whether PA prevents cognitive decline or cognitively healthier individuals remain more active cannot be determined. Convenience sampling may limit generalizability, and self-reported PA data may be subject to recall bias, though IPAQ has demonstrated acceptable validity across populations and cross-cultural settings (Craig et al., 2003). Potential confounders such as socioeconomic status, nutritional status, comorbidity index, medication use, genetic factors and PA type (aerobic versus resistance, leisure versus occupational) were not controlled for, warranting attention in future research.

Psychiatric exclusion was dependent upon self-reported diagnosis and clinical history instead of a proven screening tool and it is therefore another unmeasured possible confounder of a depressed subject if depressive symptomatology is recognised to have independent influences on processing speed memory and an older subject's readiness to activity then one is warranted to include a proven such as the Geriatric Depression Scale-15 (GDS-15) in future studies, or the Patient Health Questionnaire (PHQ-9), which are validated in the Indian population (Mehra et al.,2021). Furthermore, Pearson correlation and ANOVA are unadjusted, and age, sex, education, and comorbidity may confound this association; hence longitudinal studies tracking PA and cognitive performance over time, randomised controlled trials of structured exercise programmes, and investigations of intermediary mechanisms including cardiovascular fitness, inflammatory markers and brain structure are needed. Research on barriers to PA and culturally relevant intervention strategies will be essential to sustain engagement among diverse Indian older adult groups.

5. Conclusion

This cross-sectional study found a significant positive correlation between the level of PA and cognition of community-dwelling older adults in Delhi-NCR. The present study indicated that most of the study subjects performed at least a moderate level of PA which was below the recommendations and a good proportion of subjects performed poorly on the cognition assessment with mild cognitive impairment. The present study found a dose-dependent relationship between PA and cognitive performance of participants, that is a higher activity level correlated significantly with higher scores in cognitive tests.

This positive relationship suggests that promoting the level of PA in the older age group can bring benefits for cognitive health. This study clearly highlights the relevance of physical activity as a modifiable behavioural factor for healthy cognitive ageing and prevention of age-related cognitive decline in the older population in India, the number of which is predicted to rapidly rise. Public health interventions focusing on increasing awareness for adopting an active lifestyle among older people, creating an age-friendly environment, and addressing factors like ageism and gender differences should be introduced which might go a long way in maintaining good cognitive functioning and quality of life in older Indians. Longitudinal studies and intervention trials should be done to demonstrate a cause-and-effect relationship and to provide a basis for interventions for this demographic.

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Availability of data and material

All data generated or analyzed during the study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare no conflict of interest.

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Author contributions

Conceptualization: A, SJ; Methodology: AJ, KS; Data curation: A, KS; Formal analysis: SJ, A; Writing-Original draft: KS, A; Writing-Review & Editing: SJ, AJ.

References

Blondell, S. J., Hammersley-Mather, R., & Veerman, J. L. (2014). Does physical activity prevent cognitive decline and dementia? A systematic review and meta-analysis of longitudinal studies. BMC Public Health, 14, 510. https://doi.org/10.1186/1471-2458-14-510

Buchman, A. S., Boyle, P. A., Yu, L., Shah, R. C., Wilson, R. S., & Bennett, D. A. (2012). Total daily physical activity and the risk of AD and cognitive decline in older adults. Neurology, 78(17), 1323-1329. https://doi.org/10.1212/WNL.0b013e3182535d35

Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., Elavsky, S., Marquez, D. X., Hu, L., & Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 61(11), 1166-1170. https://doi.org/10.1093/gerona/61.11.1166

Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. Psychological Science, 14(3), 125-130. https://doi.org/10.1111/1467-9280.t01-1-01430

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. Medicine & Science in Sports & Exercise, 35(8), 1381-1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Dey, A. B., Soneja, S., Nagarkar, K. M., & Jhingan, H. P. (2001). Evaluation of the health and functional status of older Indians as a prelude to the development of a health programme. The National Medical Journal of India, 14(3), 135-138.

Dias, A., & Patel, V. (2009). Closing the treatment gap for dementia in India. Indian Journal of Psychiatry, 51(Suppl 1), S93-S97.

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., Kim, J. S., Heo, S., Alves, H., White, S. M., Wojcicki, T. R., Mailey, E., Vieira, V. J., Martin, S. A., Pence, B. D., Woods, J. A., McAuley, E., & Kramer, A. F. (2011). Exercise training increases size of hippocampus and improves memory. Proceedings of the National Academy of Sciences, 108(7), 3017-3022. https://doi.org/10.1073/pnas.1015950108

International Institute for Population Sciences (IIPS), National Programme for Health Care of the Elderly (NPHCE), MoHFW, Harvard T.H. Chan School of Public Health (HSPH), & University of Southern California (USC). (2020). Longitudinal Ageing Study in India (LASI) Wave 1, India Report. Mumbai: IIPS.

IPAQ Research Committee. (2005). Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)-Short and Long Forms. Retrieved from http://www.ipaq.ki.se (archived version)

Kaul, S., Paplikar, A., Varghese, F., Alladi, S., … & Padma, M. V. (2022). MoCA in five Indian languages: A brief screening tool to diagnose dementia and MCI in a linguistically diverse setting. International Journal of Geriatric Psychiatry, 37(9). https://doi.org/10.1002/gps.5808

Kumar, M., Srivastava, S., & Muhammad, T. (2022). Relationship between physical activity and cognitive functioning among older Indian adults. Scientific Reports, 12, 2725. https://doi.org/10.1038/s41598-022-06725-3

Kramer, A. F., & Erickson, K. I. (2007). Capitalizing on cortical plasticity: Influence of physical activity on cognition and brain function. Trends in Cognitive Sciences, 11(8), 342-348. https://doi.org/10.1016/j.tics.2007.06.009

Langa, K. M., & Levine, D. A. (2014). The diagnosis and management of mild cognitive impairment. JAMA, 312(23), 2551–2561. https://doi.org/10.1001/jama.2014.13806

Liu-Ambrose, T., Nagamatsu, L. S., Graf, P., Beattie, B. L., Ashe, M. C., & Handy, T. C. (2010). Resistance training and executive functions: A 12-month randomized controlled trial. Archives of Internal Medicine, 170(2), 170-178. https://doi.org/10.1001/archinternmed.2009.494

Mehra, A., Agarwal, A., Bashar, M., & Grover, S. (2021). Evaluation of psychometric properties of Hindi versions of Geriatric Depression Scale and Patient Health Questionnaire in older adults. Indian Journal of Psychological Medicine, 43(4), 319–324. https://doi.org/10.1177/02537176211022159

Murman, D. L. (2015). The impact of age on cognition. Seminars in Hearing, 36(3), 111-121. https://doi.org/10.1055/s-0035-1555115

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. Journal of the American Geriatrics Society, 53(4), 695-699. https://doi.org/10.1111/j.1532-5415.2005.53221.x

Northey, J. M., Cherbuin, N., Pumpa, K. L., Smee, D. J., & Rattray, B. (2018). Exercise interventions for cognitive function in adults older than 50: A systematic review with meta-analysis. British Journal of Sports Medicine, 52(3), 154-160. https://doi.org/10.1136/bjsports-2016-096587

Rajan, S. I., Sarma, P. S., & Mishra, U. S. (2003). Demography of Indian aging, 2001-2051. Journal of Aging & Social Policy, 15(2-3), 11-30. https://doi.org/10.1300/J031v15n02_02

Ramamoorthy, T., Kulothungan, V., & Mathur, P. (2022). Prevalence and correlates of insufficient physical activity among adults aged 18–69 years in India: Findings from the National Noncommunicable Disease Monitoring Survey. Journal of Physical Activity and Health, 19(3), 150–159. https://doi.org/10.1123/jpah.2021-0688

Smith, P. J., Blumenthal, J. A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., Browndyke, J. N., & Sherwood, A. (2010). Aerobic exercise and neurocognitive performance: A meta-analytic review of randomized controlled trials. Psychosomatic Medicine, 72(3), 239-252. https://doi.org/10.1097/PSY.0b013e3181d14633

Sofi, F., Valecchi, D., Bacci, D., Abbate, R., Gensini, G. F., Casini, A., & Macchi, C. (2011). Physical activity and risk of cognitive decline: A meta-analysis of prospective studies. Journal of Internal Medicine, 269(1), 107-117. https://doi.org/10.1111/j.1365-2796.2010.02281.x

Stern, Y. (2012). Cognitive reserve in ageing and Alzheimer's disease. The Lancet Neurology, 11(11), 1006-1012. https://doi.org/10.1016/S1474-4422(12)70191-6

Sun, F., Norman, I. J., & While, A. E. (2013). Physical activity in older people: A systematic review. BMC Public Health, 13, 449. https://doi.org/10.1186/1471-2458-13-449

Tiedemann, A., Sherrington, C., Close, J. C., & Lord, S. R. (2011). Exercise and Sports Science Australia position statement on exercise and falls prevention in older people. Journal of Science and Medicine in Sport, 14(6), 489-495. https://doi.org/10.1016/j.jsams.2011.04.001

United Nations. (2020). World Population Ageing 2020 Highlights: Living Arrangements of Older Persons. Department of Economic and Social Affairs, Population Division.

United Nations Population Division. (2019). World Population Prospects 2019. United Nations Department of Economic and Social Affairs.

Voss, M. W., Vivar, C., Kramer, A. F., & van Praag, H. (2013). Bridging animal and human models of exercise-induced brain plasticity. Trends in Cognitive Sciences, 17(10), 525-544. https://doi.org/10.1016/j.tics.2013.08.001

World Health Organization. (2015). World Report on Ageing and Health. Geneva: WHO.

World Health Organization. (2020). WHO Guidelines on Physical Activity and Sedentary Behaviour. World Health Organization.