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ORIGINAL ARTICLE

Clinical and neuropsychological characterization of SuperAgers residing in Delhi and National Capital Region of India—A cross-sectional study

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Abstract

Introduction: SuperAgers (SA) are older adults who exhibit cognitive capacities comparable to individuals who are three or more decades younger than them. The current study aimed to identify the characteristics of Indian SA by categorizing 55 older adults into SA and Typical Older Adults (TOA) and comparing their performance with a group of 50 younger participants (YP) (aged 25–50).

Methods: A total of 105 participants were recruited after obtaining informed written consent. The cognitive abilities of the participants were assessed using Wechsler Adult Intelligence Scale (WAIS)-IV^{INDIA}, Color Trails Test, Boston Naming Test (BNT), and Rey Auditory Verbal Learning Test.

Results: SA outperformed TOA in all cognitive assessments ($P < 0.001$) and surpassed YP in BNT and WAIS-IV. SA's delayed recall scores were notably higher (12.29 ± 1.51) than TOA (6.32 ± 1.44).

Conclusion: SA excelled in all cognitive domains demonstrating resilience to age-related cognitive decline. This study highlights Indian SuperAgers' exceptional cognitive prowess.

KEYWORDS
cognition, episodic memory, Indian SuperAgers, neuropsychological characterization

1 | INTRODUCTION

One of the most pressing challenges encountered by individuals as they age is the gradual decline in memory and cognitive functions.[1] This becomes even more significant in a world experiencing an unprecedented growth of older populations, where the number of individuals with memory decline is alarmingly on the rise.[2] Amidst this backdrop, there exists a remarkable group of individuals known as SuperAgers (SA) who seemingly defy the effects of time on their cognitive abilities. SA exhibit exceptional problem-solving skills, memory retention, and retrieval capabilities that mirror those of individuals who are three decades younger.[3]

Ritika Batra and Deepa Anil Kumar contributed equally as the first authors.

While prior research[1,3], primarily conducted in developed nations, has often set the age cutoff for SA at 80 years and older, it is essential to consider the diverse factors that come into play in developing countries. Given the differences in life expectancy, socio-cultural aspects, and education levels of older adults in these regions, the age cutoff for SA in the developing countries has been proposed to be 75 years.[4]

The substantial variation in the degree of cognitive decline with aging made the researchers ponder the underlying factors responsible for the unusually intact cognitive abilities exhibited by SA.[5] Variations were reported in the performance in neurocognitive assessments and the brain structure.[1,3] These prior studies were conducted on the Caucasian population, and there are a paucity of data on the SA in the Indian context. Hence, the clinical and psycho-social characteristics of Indian SuperAgers need to be evaluated considering their socio-cultural and epigenetic differences from the Caucasian population. Successful cognitive aging is linked to various clinical elements and psychological and lifestyle differences. The present study was the first of its kind aimed at the clinical and psycho-social characterization of Indian SuperAgers residing in Delhi and the National Capital Region.

2 | MATERIALS AND METHODS

2.1 | Study design

The present cross-sectional study was conducted in the Department of Geriatric Medicine, All India Institute of Medical Sciences (AIIMS), New Delhi, after obtaining approval from the Institute Ethics committee (Ref No. IEC/199/05.04.2019, RP-43/2019).

2.2 | Sampling

A convenience sampling strategy was adopted, considering the novelty of the study. The participants were recruited through multiple community visits, circulating advertisements via printed and electronic media, publishing the advertisement on the official websites of the institute and, telephonic and written communication to the senior citizens' Residents Welfare Associations in South Delhi.

2.3 | Participants

Fifty-five older adults aged 75 and above, with a minimum of 16 years of education, who are proficient in English, and who scored zero on the Clinical Dementia Rating (CDR) scale,[6] were recruited in the study after obtaining informed, written consent. Individuals having dementia or mild cognitive impairment, visual and/or auditory limitations that impair the performance of cognitive tests, and having a diagnosis of a major neuropsychiatric disorder were excluded. Fifty younger participants (YP) aged between 25 and 50 were recruited after obtaining informed written consent.

Demographic characteristics age, gender, marital status, type of family, financial independence, living arrangement, and co-morbidity conditions were collected through face-to-face questionnaire survey. "Modified Kuppuswamy socioeconomic scale updated for the year 2021" was used to determine the socioeconomic status. This scale consists of a composite score including education and occupation of the head of the family along with the monthly income of the family. The total score ranges from 3 to 29. This scale divides the population into upper (score, 26–29), upper middle (score, 16–25), lower middle (11–15), upper lower (5–10), and lower socioeconomic status (score, <5).[7]

2.4 | Neuropsychological assessments

The participants underwent neuropsychological assessment administered by a trained psychologist. This included both questionnaire and performance-based assessments. The participants completed the tests either in one sitting that lasted 2 to 3 h or in multiple sittings within a week, based on their convenience.

The following tools were used for the assessment:

a. The 60-item Boston Naming Test (BNT): The Boston Naming Test[8] was employed to assess semantic or visual perceptual processing. The psychologist showed each of the pictures to the study participants one at a time in the given order. The participant was given 20 seconds to say what the picture depicts. Another 20 s was given to identify the picture. If they could not correctly identify the drawing in the allotted time, the test administrator moved on to the next drawing. Typically, each correct answer, whether given before or after verbal cues, was counted as one point. If a participant fails to recall the word, phonemic cues such as "ca" for "cactus" were used to represent that the word exists in the person's mental lexicon.
b. Color Trails Test (CTT): The CTT[9] was employed to assess graphomotor skills, sustained visual attention, and visual scanning. It had numbered circles printed with vivid pink or yellow backgrounds that were perceptible to color-blind individuals. The test has two parts, Form 1 and Form 2. For Form 1, the participants were required to rapidly connect circles numbered 1–25 in sequence using a pencil. For Form 2, they were instructed to connect numbered circles in sequence, alternating between pink and yellow. The time required to complete each trial was recorded, along with qualitative features of performance indicative of brain dysfunction, such as near-misses, prompts, number sequence errors, and color sequence errors. The lower the CTT raw score (time taken in seconds), the higher the participants' sustained attention.
c. The Rey Auditory Verbal Learning Test (RAVLT): The RAVLT[10] was used to evaluate a wide diversity of functions such as episodic memory, rate of learning, learning strategies, retroactive and proactive interference, presence of confabulation of confusion in memory processes, retention of information, and the differences

between learning and retrieval. The participants were given a list of 15 unrelated words repeated over five trials and asked to repeat them. Another list of 15 unrelated words was given, and the participants were asked to repeat the original list of 15 words. After 30 min they were asked to recall the words from the first list which was assessed as "delayed recall." Approximately 10 to 15 min were required for the procedure (not including 30 min intervals).

d. Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) India: The WAIS-IV[11] comprises 10 core subtests and 5 supplemental subtests, with the 10 core subtests comprising the Full-Scale IQ (FSIQ). The four index scores representing major components of intelligence were the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Working Memory Index (WMI), and Processing Speed Index (PSI). FSIQ was calculated based on the total combined performance in these components.

2.5 | Classification of older adults into Typical Older Adults (TOA) and SuperAgers (SA)

Given the absence of established neuropsychological classification criteria specifically validated for older individuals in the Indian context, we adopted a set of criteria according to Rogalski et al. for classification of older adults into TOA and SA. It was based on two primary measures: delayed recall scores obtained in the RAVLT,[5] and FSIQ scores by WAIS-IV.[12] To qualify as SA, older adults needed to obtain a score of ≥9 in the delayed recall domain in RAVLT and ≥110 on the FSIQ in WAIS-IV.

2.5.1 | Statistical analysis

The data was analyzed using a statistical package for social sciences (SPSS, Version 24.0) software (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.). Continuous data were expressed as mean, standard deviation (SD) and qualitative data were expressed as number and percentage as appropriate. Data were tested for normality using the Kolmogorov–Smirnov/Shapiro- Wilk test. ANOVA test was used to compare the normal variables among the groups. The Kruskal-Wallis test compared the non-normally distributed variables among the groups, followed by Bonferroni-Correction. For categorical data, the Chi-square/Fisher's exact test was performed to see the association. A value of $p \leq 0.05$ was considered statistically significant.

3 | RESULTS

3.1 | Demographic details of the study participants

A total of 105 individuals took part in the study, which included 55 older adults aged 75 years and above and 50 younger participants (YP). Out of 55 older adults, 40 (72%) were males, and 15 (28%) were females, whereas the gender distribution among the younger group was 26 (52%) males and 24 (48%) females. The mean age of the participants in SA, typical older adults (TOA), and YP was 78.96 ± 4.19, 77.64 ± 3.25, and 34.46 ± 8.09, respectively.

TABLE 1 Comparison of the demographic details of Typical Older Adults (TOA) and SuperAgers (SA).

Variables	TOA ($n = 31$)	SA ($n = 24$)	p-Value
Age (years)	77.64 ± 3.25	78.96 ± 4.19	0.196
Education level			
Education Years	16.00 ± 1.41	16.30 ± 1.32	>0.999
Graduation	19 (61.29)	10 (41.66)	0.148
Profession or Honors	12 (38.70)	14 (58.33)	
Marital status			
Married	23 (74.19)	17 (70.83)	
Widowed	6 (19.35)	6 (25)	0.840
Single	2 (6.45)	1 (4.16)	
Occupation			
Legislators, Senior Officials & Managers	4 (12.90)	1 (4.16)	
Professionals	16 (51.61)	14 (58.33)	
Technicians and Associate Professionals	4 (12.90)	5 (20.83)	
Clerks	1 (3.22)	–	
Skilled Workers and Shop & Market Sales Workers	3 (9.67)	3 (12.50)	
Unemployed	3(9.67)	1(4.16)	
Socioeconomic status			
Upper	6 (19.35)	10 (41.66)	
Upper middle	20 (68.96)	13 (54.16)	0.278
Lower middle	3 (10.34)	1 (4.16)	
Type of family			
Nuclear	16 (51.61)	10 (41.66)	0.459
Joint	12 (38.70)	17 (54.16)	
Long-term Care Centre	3 (9.67)	1 (4.16)	
Financial dependence			
Yes	8 (25.80)	3 (12.50)	0.387
No	23 (74.19)	21 (87.50)	

Demographic details of the TOA and SA were compared (Table 1). There was no statistically significant difference recorded in education, occupation, or socioeconomic level across the groups. The most common comorbidities in TOA were diabetes mellitus (45.16%), hypertension (38.71%), connective tissue disorders (22.58%), and chronic obstructive pulmonary disease (COPD) (19.35%). In comparison, the most common co-morbidities in the SA group were hypertension (37.50%), diabetes mellitus (37.50%), COPD (12.50%), and connective tissue disorder (8.33%).

3.1.1 | The Boston Naming Test (BNT)

In the Boston Naming Test, SA showed superior naming ability compared to TOA. The mean score of the correct responses in the BNT revealed a significant difference ($p < 0.001$) among SA, TOA, and YP groups, with SA having the highest (58.08 ± 1.52) scores (Table 2).

3.1.2 | Color Trail Test (CTT)

There was a statistically significant difference between the SA and TOA both in CTT1 ($P < 0.001$) and CTT2 ($P < 0.001$) scores. The TOA took the highest time to complete the CTT1 task with a mean ± SD of 100.29 ± 32.44, followed by SA (62.29 ± 27.58) and YP (48.1 ± 19.09) groups. Similarly, the mean score for the CTT2 was 186.09 ± 43.87 in the TOA group, 123.54 ± 37.66 in the SA group, and 94.6 ± 32.17 in the YP group (Table 2).

3.1.3 | Wechsler Adult Intelligence Scale-IV (WAIS–IV)

The present study revealed a statistically significant difference ($P < 0.001$) in the mean score of WAIS-IV among the YP, TOA, and SA group, with the SA group having the highest score (116.58 ± 6.53), followed by YP (95.3 ± 12.18) and TOA group (90.48 ± 5.72) (Table 2).

3.1.4 | The Rey Auditory Verbal Learning Test (RAVLT)

The mean SD score of the RAVLT trails I-V revealed a significant difference among the group ($p = <0.001$). The scores were found to be higher in the SA group (38.45 ± 10.33) as compared to the TOA (31.90 ± 6.57). The mean ± SD scores of the delayed recall domain were also found to be higher in SA (12.29 ± 1.51) than in the TOA group (6.32 ± 1.44) (Table 2).

4 | DISCUSSION

With aging, the human race faces the challenge of maintaining cognitive health in the later stages of life, particularly beyond the ages of 75 and 80. This presents a substantial obstacle to active aging, impacting not only the global economy but also the overall quality of life and leading to socio-economic implications across populations and policies. Within this aging demographic, the community of SuperAgers stands as an exemplar of positive prospects.

TABLE 2 Scores of neuropsychological tests of SA, TOA, and YP groups.

Variables	YP	TOA	SA	*p*-Value
BNT	56.60 ± 2.50	51.09 ± 3.38	58.08 ± 1.52	<0.001[a]
Color trails test				
Form 1	48.10 + 19.08	100.29 ± 32.44	62.29 ± 27.58	<0.001[b]
Form 2	94.60 ± 32.17	186.09 ± 43.87	123.54 ± 37.66	<0.001[c]
WAIS IV	95.30 ± 12.18	90.48 ± 5.72	116.58 ± 6.53	<0.001[d]
RAVLT				
Trials I-V	49.34 ± 10.08	31.09 ± 6.57	38.45 ± 10.33	<0.001[e]
List B	6.12 ± 1.94	3.41 ± 1.56	4.95 ± 1.89	<0.001[f]
Trial VI	10.82 ± 2.67	6.64 ± 2.27	7.75 ± 2.98	<0.001[g]
Recognition	13.52 ± 1.91	9.77 ± 2.61	13.33 ± 1.23	<0.001[h]
Delayed Recall	12.88 ± 1.45	6.32 ± 1.44	12.29 ± 1.51	<0.001

Abbreviations: BNT, Boston Naming Test; RAVLT, Rey Auditory Verbal Learning Test; SA, SuperAgers; TOA, typical older adults; WAIS-IV, Wechsler Adult Intelligence Scale-IV; YP, younger participants.

[a]Post-hoc: significant difference between YP and TOA ($p < 0.001$), TOA and SA ($p < 0.001$).

[b]Post-hoc: significant difference between YP and TOA ($p < 0.001$), TOA and SA ($p < 0.001$).

[c]Post-hoc: significant difference between YP and TOA ($p < 0.001$), YP and SA ($p = 0.007$), TOA and SA ($p < 0.001$).

[d]Post-hoc: significant difference between YP and SA ($p < 0.001$), TOA and SA ($p < 0.001$).

[e]Post-hoc: significant difference between YP and TOA ($p < 0.001$), YP and SA ($p < 0.001$), TOA and SA ($p = 0.032$).

[f]Post-hoc: significant difference between YP and TOA ($p < 0.001$), YP and SA ($p = 0.036$), TOA and SA ($p = 0.008$).

[g]Post-hoc: significant difference between YP and TOA ($p < 0.001$), YP and SA ($p < 0.001$).

[h]Post-hoc: significant difference between YP and TOA ($p < 0.001$), TOA and SA ($p < 0.001$).

Since India is a developing country with a heterogeneous population having differences in literacy levels and culture, we adopted an age cutoff of 75 for participants instead of the typical 80+ age range used to define SuperAgers as proposed by Borelli et al.[3] It has been reported that level of education is one of the strongest determinants of neuropsychological test performance.[13] While the majority of SA was post-graduates, the TOA in the present study were predominantly undergraduates although the difference was not statistically significant. It has been reported that education plays a major role in cognitive reserve capacity in late life which has been studied extensively in people with cognitive impairment.[14,15] The present study showed the opposite side of the paradigm where SA are expected to be more literate, corroborating with the findings by Balduino et al.[16] It was also noted that a substantial proportion of SA belonged to the upper socioeconomic stratum and lived in joint families, indicating a potential association between higher socioeconomic status and living arrangements with successful aging. Further, most of the older participants were males, which might be a socio-cultural indicator of higher education among males in comparison to females.

4.1 | Episodic memory and SuperAgers

Episodic memory is the interaction of various brain regions, including the hippocampus, prefrontal cortex, and medial temporal lobe, to store and retrieve information. Previous research has demonstrated that SuperAgers had above-average-for-age episodic memory, indicating resilience to age-related memory deterioration.[17]

The RAVLT used in the present study revealed that the average of the total learning scores—immediate and delayed recall and recognition—for the SA group was higher than those of their age-matched TOA group and younger participants ($p < 0.001$).

SA's higher delayed recall scores may be attributed to their exceptional performance on the IQ test and more years of education. As per previous studies, intellectual ability can compensate for attention and memory deficits by positively influencing the retrieval and application of prior knowledge in the task performance.[18] The findings of the present study on the greater delayed recall ability in SA are in corroboration with that of a study conducted by Rogalski et al.[5] The higher scores of the YP group than the TOA in all these domains could be attributed to age differences, as the performance of subjects on the RAVLT has been reported to decline with increasing age.[19,20]

4.2 | Semantic codes and SuperAgers

It has been found in earlier studies that stable lexical and semantic representations play a significant role in memory tasks, especially immediate recall.[21] The SuperAgers group in the present study outperformed their age-matched typical memory counterparts and younger participants ($p < 0.001$) as assessed by BNT. Further, SA needed fewer semantic and phonemic cues compared to the other two groups. The greater mean ± SD in the BNT score of the SA group (58.08 ± 1.52) as compared to the TOA (51.09 ± 3.38) could be linked to their superior performance in semantic and visual-perceptual processing abilities. Spontaneous naming errors were recorded in the responses by TOA. The present study is the first to showcase these findings, emphasizing a prospective hypothesis associating high BNT test scores and minimal demand for retrieval cues with superaging.

4.3 | Sustained attention and SuperAgers

Sustained attention refers to the capability to maintain vigilance throughout time and is viewed as a fundamental attention process.[22] The CTT employed in the current study revealed that the scores of sustained attention tests to be the lowest in the TOA group. SA showed superior sustained attention and could better retain their focus and concentration for a prolonged period. Compared to TOA, SA displayed outstanding resilience to aging and cognitive decline ($p < 0.001$). A higher IQ may be attributed to SuperAgers' superior performance since it measures cognitive abilities required for various tasks, such as problem-solving, memory, and reasoning skills. The younger group completed both forms substantially faster than the older group ($p < 0.001$). This finding is in corroboration with previous findings, which indicates that age appears to have a significant impact on performance.[23,24]

4.4 | Intelligence quotient and SuperAgers

The relationship between cognitive control skills and intelligence quotient (IQ) is widely known.[25] While some cognitive abilities like verbal intellectual abilities and reading skills persist into older adulthood, other cognitive abilities (e.g., memory and processing speed) decline more rapidly with age.[26] According to Salthouse,[27] the relative age trends on Vocabulary, Similarities, Block Design, and Digit Symbol examinations have been relatively similar between 1955 and 2008 suggesting that, though the absolute performance levels have shifted over time, the connection between older and younger adults has remained relatively stable.[26] Contrary to findings which indicated that the SuperAging group and their age-matched controls had similar IQ scores,[28] the present study demonstrated a statistically significant difference between the SA and TOA groups on the WAIS-IV Full IQ ($p < 0.001$), with the SA group scoring the highest. This discrepancy in observation might have resulted from multiple reasons, including variations in the study population, a small sample size, or differences in the tool implemented for measuring IQ. Cognitive abilities, particularly those linked to processing speed and memory, deteriorate steadily as people age.[26] In the current study, however, the SA group outperformed the TOA group in all WAIS-IV sub-domains and the YP

group on the overall IQ score, displaying resilience to age-related cognitive deterioration.

5 | LIMITATION

Considering the socio-cultural differences within the Indian population, and the study was limited to Delhi/ NCR, the findings of the study cannot be generalized.

6 | CONCLUSION

The current study is pioneering in its exploration of the clinical characteristics of Indian SuperAgers. The study's findings indicate that SuperAgers excel in memory tasks, exhibit higher IQ scores, and demonstrate enhanced cognitive functioning across multiple domains and fared better than typical adults and, in certain cases, even surpassed the cognitive capacities of younger people. Additionally, we observed that individuals with higher education levels and those from more affluent socioeconomic backgrounds have a greater likelihood of achieving SuperAger status. This emphasizes the significance of modifications to policies and implementation to support these inferences. A longitudinal study is essential to track the trajectory of SuperAgers and assess their long-term performance compared to typical older adults across various regions and contexts. Overall, this study underscores an exciting and promising area of research that will continue to yield valuable insights into exceptional brain aging and the potential for preserving cognitive skills in older people.

AUTHOR CONTRIBUTIONS

Conceived and designed the entire study: PC; psychological assessment: RB; preparation of the first draft of manuscript: RB & DAK; statistical analysis: MAK, AR; reviewed the manuscript: PC, AC, NS, PK, AR, GSK, & SS.

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CONFLICT OF INTEREST STATEMENT

None to declare.

DATA AVAILABILITY STATEMENT

The data are available with the corresponding author and are available on reasonable request.

ETHICS STATEMENT

The present study was conducted in the Department of Geriatric Medicine, All India Institute of Medical Sciences (AIIMS), New Delhi, after obtaining approval from the Institute Ethics committee (Ref No. IEC/199/05.04.2019, RP-43/2019).

PATIENT CONSENT STATEMENT

Participants were recruited in the study after obtaining informed, written consent.

PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

Not Applicable.

CLINICAL TRIAL REGISTRATION

Not Applicable.

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