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Sensory Processing in Aging: A Comparative Study of Institutionalized and Community-Dwelling Elders Using Dunn's Framework

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Abstract

Background: Sensory processing patterns significantly influence functional independence and quality of life among older adults.

Objectives: This study compared these patterns between institutionalized and community-dwelling Iranian older adults using Dunn's framework.

Methods: In this cross-sectional analytical study, 172 adults aged 60 - 70 years (86 institutionalized and 86 community-dwelling) from Semnan Province were assessed using the Adolescent/Adult Sensory Profile (AASP). Data were analyzed using independent *t*-tests and chi-square tests.

Results: Significant differences were observed across all four sensory quadrants. Community-dwelling elders had a higher prevalence of Sensation Seeking (38.4% vs. 18.6%; Cohen's d = 0.64; $P < 0.001$) and Low Registration (30.2% vs. 16.3%; d = 0.52; P = 0.002). In contrast, institutionalized elders had higher rates of Sensation Avoiding (33.7% vs. 19.8%; d = 0.44; P = 0.004) and Sensory Sensitivity (31.4% vs. 11.6%; d = 0.71; $P < 0.001$). All differences were statistically significant.

Conclusions: The living environment is strongly associated with sensory processing patterns in older adults. Enriched sensory environments and targeted sensory-based rehabilitation in care facilities may promote more adaptive patterns and enhance well-being.

Keywords: Sensory Processing Patterns, Institutionalized, Community-Dwelling, Older Adults, Dunn's Model

1. Background

With rising life expectancy and improvements in healthcare, the global older population is increasing rapidly. It is estimated that by 2050, individuals aged 60 years and older will comprise nearly one-third of the population in many countries (1). In Iran, population aging is also accelerating, and forecasts predict a significant increase in the proportion of older adults in the coming decades (2). This demographic transition underscores the importance of promoting quality of life, functional independence, and social participation among older adults.

One of the key factors affecting quality of life in aging is an individual's ability to perceive, process, and appropriately respond to environmental sensory information. Age-related neural changes may contribute to differences in sensory processing (3). These changes may be associated with reduced social engagement, difficulties in activities of daily living, balance problems, and cognitive decline (3, 4). Multiple studies have confirmed that inefficient sensory processing in older adults is associated with diminished independence, increased fall risk, mood disorders, anxiety, and, ultimately, poorer mental and physical health outcomes (4-6). In addition, the brain's ability to integrate

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multisensory information tends to decline with age, which may be related to either hypersensitivity or sensory under-responsiveness (7).

In this context, Dunn's Sensory Processing Framework provides a validated theoretical model for understanding individual differences in sensory responses. This model categorizes individuals into four sensory processing patterns: Sensation Seeking, Sensation Avoiding, Sensory Sensitivity, and Low Registration (8). Evaluating these patterns provides deeper insight into how older adults interact with their surroundings and informs the development of effective therapeutic and environmental interventions (9).

A major contextual factor that may be related to sensory processing in older adults is their living environment. Whether an older adult resides in an institutional care facility or in the community substantially influences their exposure to sensory stimuli. Studies suggest that institutionalized older adults, owing to exposure to monotonous, structured environments with limited stimulation, are more likely to exhibit higher levels of sensitivity and avoidance, whereas community-dwelling seniors, who are more actively engaged in dynamic environments, may demonstrate greater sensory-seeking tendencies and adaptive responsiveness (10, 11). Despite the recognized importance of sensory processing in aging, previous research has often focused on specific populations or examined the issue from a single perspective. Few studies have directly compared institutionalized and community-dwelling older populations, particularly across diverse sociocultural settings. Moreover, in countries such as Iran, there remains a need for localized, culturally relevant research using validated sensory assessment tools.

2. Objectives

Given the potential impact of living context on sensory processing patterns, the present study aimed to compare sensory processing in institutionalized and community-dwelling older adults using Dunn's framework. The findings are expected to provide valuable insights for geriatric care professionals, rehabilitation specialists, and policymakers in designing sensory-based interventions and age-friendly environments tailored to the diverse needs of older adults.

3. Methods

3.1. Study Design

This descriptive-analytical, cross-sectional comparative study examined and compared sensory processing patterns among institutionalized and community-dwelling older adults based on Dunn's sensory processing model. The study was conducted between September and December 2023 in Semnan Province.

3.2. Participants and Sampling

The study population comprised older adults aged 60 to 70 years. The institutionalized group (n = 86) resided in long-term elderly care facilities providing 24-hour supervision. The community-dwelling group (n = 86) comprised older adults living independently in their own homes or with family in the general community, without formal 24-hour institutional care.

A non-probability convenience sampling method was used to recruit participants from elderly care and rehabilitation centers affiliated with Semnan University of Medical Sciences and from community centers. The sample size was calculated using the Cochran formula, with a confidence level of 95% (Z = 1.96), a proportion of the outcome (P = q = 0.5), and a margin of error (e = 0.07), resulting in a required sample of 168 participants.

3.3. Inclusion and Exclusion Criteria

To account for potential attrition, 4 additional individuals were included, yielding a final sample of 172 older adults (86 in each group). Participants were eligible if they were 60 - 70 years old, literate, scored ≥ 21 on the MMSE, and provided informed consent. Exclusion criteria included major psychiatric disorders (e.g., major depression, schizophrenia, or confirmed dementia); severe visual or auditory impairments that interfered with sensory function; neurological or physical disorders affecting participation; and withdrawal or non-compliance during data collection.

3.4. Research Procedure

After obtaining ethical approval from the Semnan University of Medical Sciences Ethics Committee (IR.SEMUMS.REC.1401.267), the study protocol was initiated. To minimize bias, all assessments were administered by a trained evaluator following standardized instructions. Participants were screened for cognitive function using the MMSE to exclude individuals with significant cognitive impairment that could compromise the validity of self-reported responses on the AASP questionnaire. All responses were anonymized using participant codes and stored securely in a password-protected system. Data were

initially entered into Microsoft Excel and then analyzed using SPSS version 27. Only authorized research team members had access to the dataset, and no identifiable information was recorded.

3.5. Data Collection Tools

1) Demographic Questionnaire: included items on age, sex, education, marital status, and living arrangement.

2) Adolescent/Adult Sensory Profile (AASP): developed by Dunn, is a standardized tool comprising 60 items that measure four sensory processing patterns: Low Registration, Sensation Seeking, Sensation Avoiding, and Sensory Sensitivity (12, 13). Responses are rated on a 5-point Likert scale from 1 ("Rarely") to 5 ("Almost Always"). Each quadrant score ranges from 15 to 75. The validated Persian version was used, with reported Cronbach's alpha values ranging from 0.894 to 0.916 and Intraclass Correlation Coefficients (ICC) between 0.885 and 0.948, confirming high reliability and validity (14).

3) Mini-Mental State Examination (MMSE): a 30-item cognitive screening tool assessing orientation, memory, attention, language, and visuospatial skills. Scores below 21 indicate cognitive impairment and were grounds for exclusion. The Persian version has demonstrated acceptable validity (r = 0.78).

3.6. Ethical Consideration

This manuscript is derived from a research project of the Student Research and Technology Committee (number 3364) and was approved by the Ethics Committee of Semnan University of Medical Sciences (number IR.SEMUMS.REC.1401.267).

3.7. Statistical Analysis

Data normality was assessed using the Shapiro-Wilk test, and homogeneity of variances was confirmed with Levene's test. Statistical analyses included descriptive statistics (means, standard deviations, frequencies, and percentages), an independent-samples *t*-test to compare mean sensory processing scores between groups, and a chi-square (χ^2) test to evaluate frequency differences in categorical sensory profile scores. Effect sizes were calculated using Cohen's d for *t*-tests and Cramér's V for chi-square tests. A P-value < 0.05 was considered statistically significant.

4. Results

A total of 172 older adults participated (86 institutionalized and 86 community-dwelling), with a mean age of 64.2 years (SD = 7.16). The groups were similar in age and gender but differed significantly in education, marital status, and MMSE scores (Table 1).

The groups were similar in gender and age; however, the institutionalized group had lower education levels ($P < 0.001$), a higher percentage of widowed individuals ($P < 0.001$), and a significantly higher mean MMSE score (26.7 vs. 24.1; $P < 0.001$).

The distribution of sensory processing patterns differed significantly between the groups (Table 2). Community-dwelling elders had higher proportions of Low Registration and Sensation Seeking, whereas institutionalized elders had higher proportions of Sensation Avoiding and Sensory Sensitivity.

Independent *t*-tests showed significant differences in mean scores across all sensory quadrants (Table 3). Community-dwelling elders scored higher in Low Registration and Sensation Seeking, whereas institutionalized elders scored higher in Sensation Avoiding and Sensory Sensitivity.

5. Discussion

This comparative study revealed a pronounced divergence in sensory processing patterns between institutionalized and community-dwelling Iranian older adults, as conceptualized by Dunn's model (8). The data indicate that institutionalized living is associated with a profile characterized by elevated Sensory Sensitivity and Sensation Avoiding, whereas community dwelling is associated with greater Sensation Seeking and Low Registration. The medium-to-large effect sizes (Cohen's d: 0.44 - 0.71) underscore that these differences are not only statistically significant but also clinically meaningful, indicating a strong association between environmental context and sensory experience in aging (3, 4).

5.1. Neuro-Environmental Mechanisms and Interpretation

The findings can be interpreted through the lens of neuroplasticity and person-environment fit. The institutionalized group's higher Sensory Sensitivity (hyper-responsiveness) and Sensation Avoiding (active withdrawal) may arise from a dual mechanism of neural vulnerability and environmental mismatch. Age-related declines in sensory gating and inhibitory neural networks can predispose older adults to sensory overload (7). In institutional settings, which are often characterized by unpredictable, uncontrollable, and monotonous stimuli (e.g., constant lighting, alarm sounds, and lack of privacy), this neural vulnerability may be exacerbated. Such environments may fail to

Table 1. Demographic Characteristics and Statistical Comparisons of Participants [a]

Variables	Community-Dwelling (n = 86)	Institutionalized (n = 86)	P-Value	Statistical Test
Age (y)	63.6 ± 6.5	64.8 ± 7.8	0.251	Independent *t*-test
Gender			1.000	Chi-square test
Men	43 (50.0)	43 (50.0)		
Women	43 (50.0)	43 (50.0)		
MMSE Score	24.1 ± 2.8	26.7 ± 2.1	< 0.001	Independent *t*-test
Education Level			< 0.001	Chi-square test
Illiterate	16 (18.6)	34 (39.5)		
High school or less	60 (69.8)	46 (53.5)		
University	10 (11.6)	6 (7.0)		
Marital Status			< 0.001	Chi-square test
Married	64 (74.4)	38 (42.2)		
Single	4 (4.7)	4 (4.7)		
Widow	16 (18.6)	42 (48.8)		
Divorced	2 (2.3)	2 (2.3)		

[a] Values are expressed as mean ± SD or No. (%). Abbreviation: MMSE, Mini-Mental State Examination. An asterisk denotes a statistically significant difference (P < 0.05).

Table 2. Frequency Distribution and Chi-Square Analysis of Sensory Processing Patterns [a]

Sensory Patterns	Community-Dwelling (n = 86)	Institutionalized (n = 86)	χ^2 (df = 1)	P-Value	φ (Cramér's V)
Low registration	26 (30.2)	14 (16.3)	10.76	0.001	0.25
Sensation seeking	33 (38.4)	16 (18.6)	12.34	< 0.001	0.27
Sensation avoiding	17 (19.8)	29 (33.7)	8.92	0.003	0.23
Sensory sensitivity	10 (11.6)	27 (31.4)	14.65	< 0.001	0.29

[a] Values are expressed as No. (%).

provide the "just-right" challenge, which could contribute to a maladaptive cycle of hypervigilance and avoidance. This interpretation aligns with the findings of Etter et al. regarding environmental constraints associated with avoidance (11).

Such settings may offer fewer opportunities to control sensory input, which could contribute to heightened vigilance (Sensitivity) and proactive withdrawal (Avoiding) (5). Conversely, the community-dwelling group's higher tendency toward Sensation Seeking is consistent with literature linking enriched, dynamic environments and greater social engagement to an active search for sensory stimulation (5, 6). The higher Low Registration scores in this group could reflect habituation or filtering mechanisms developed in response to the more complex and constant sensory input of daily community life.

5.2. Implications for Policy, Care, and Environmental Design

These results have important implications for geriatric care policy and the design of living spaces for older adults.

5.2.1. Sensory-Informed Environmental Design

For institutional settings, moving beyond basic safety toward sensory accessibility is crucial. Policy and design should prioritize:

- Controllability: allowing residents personal control over ambient elements (light, noise, and room temperature) (11).

- Zoning: creating distinct areas for stimulation (social hubs and activity rooms) and sensory respite (quiet rooms with soft furnishings).

- Naturalized input: incorporating non-threatening, rhythmic sensory input (access to gardens, aquariums, and customizable music) to provide predictable and calming stimulation that counters both monotony and overload (10).

Table 3. Comparison of Sensory Processing Scores Between Groups: Descriptive and Inferential Statistics [a]

Sensory Pattern	Community-Dwelling Group (n = 86)	Institutionalized Group (n = 86)	Independent *t*-test	Effect Size (Cohen's d)
Low registration	35.1 ± 7.2	31.2 ± 6.8	t (170) = -3.45, P = 0.002	0.52
Sensation seeking	42.3 ± 8.5	36.8 ± 7.9	t (170) = -4.21, P < 0.001	0.64
Sensation avoiding	28.5 ± 6.1	31.8 ± 6.9	t (170) = 2.89, P = 0.004	0.44
Sensory sensitivity	25.7 ± 5.9	32.4 ± 7.1	t (170) = 4.67, P < 0.001	0.71

[a] Values are expressed as mean ± SD.

5.2.2. Rehabilitation and Care Protocols

Sensory processing profiles should be integrated into individualized care plans. Occupational therapy can shift from generic activity provision to sensory modulation strategies by training staff to recognize signs of sensory overload (Avoiding and Sensitivity) and under-stimulation (Low Registration) and to respond appropriately (9).

5.2.3. Community-Based Support

For seniors aging in place, community programs should facilitate safe sensory exploration (e.g., art classes, nature walks, and intergenerational activities) to maintain neural engagement and counteract the sensory deprivation that can accompany social isolation (6). This finding aligns with a systematic review by Garmabi et al., which identified strong social networks as the most important environmental factor facilitating leisure and social participation in community-dwelling older adults. Such networks may naturally encourage sensation-seeking behavior by providing varied and novel sensory experiences (15).

5.3. Critical Appraisal of Limitations and Future Directions

While informative, this study has limitations that necessitate cautious interpretation. First, the cross-sectional design fundamentally limits causal inference. We cannot determine whether the environment shapes sensory patterns or whether individuals with pre-existing sensory sensitivities self-select or are placed into institutional care; this relationship is likely bidirectional. Second, convenience sampling from one province limits generalizability to the wider Iranian or global elderly population, particularly those in rural areas or with more severe health impairments. Importantly, this non-random sampling resulted in significant sociodemographic differences between the groups, particularly in education level and marital status (Table 1). These variables are established confounders linked to cognitive and social engagement. Therefore, they threaten the internal validity of the study, as the observed differences in sensory processing may be partially attributable to these pre-existing factors rather than solely to the living environment.

Third, although the MMSE was used only to exclude individuals with significant cognitive impairment, it does not ensure group equivalence. The groups differed significantly in education and marital status (Table 1), which are independent confounders. Important variables, including detailed physical health status, comorbidities, mental health symptoms (e.g., depression and anxiety), medication use, sleep quality, and precise socioeconomic status, were not systematically measured or matched. Differences in these unmeasured factors between the groups could have influenced sensory processing patterns independently, or through interactions with the living environment, thereby limiting the internal validity of the associational interpretations. Moreover, a study of Iranian immigrant students by Araghi et al. reported significant positive associations between anxiety and sensory sensitivity, avoidance, and low registration (16). Although we did not directly measure anxiety in our sample, the higher rates of sensitivity and avoidance observed in institutionalized elders could be partially explained by potential group differences in psychological distress; this possibility should be examined in future research. Furthermore, conducting multiple statistical comparisons (e.g., four *t*-test) without adjustment increases the family-wise error rate; therefore, the reported p-values should be interpreted with this limitation in mind. In addition, the inclusion criterion limiting participants to ages 60 - 70 years, although intended to control for severe age-related sensory and cognitive pathologies, also restricts the generalizability of the findings. Sensory processing patterns and their interaction with the environment may differ in the "old-old" population (e.g., over 75), who experience a higher burden of biological aging. Finally, although the AASP is a validated tool for adults, its performance and interpretation in very old populations, particularly those with mild cognitive

impairment not captured by the MMSE cutoff, require further specific validation.

Given these important limitations, the present findings should be interpreted as demonstrating a strong association between the living environment and sensory profiles. Nevertheless, the consistent pattern and medium-to-large effect sizes across all sensory quadrants indicate a robust signal that warrants further investigation under more controlled conditions. Future research should prioritize longitudinal and mixed-methods designs to clarify causality and explore the lived experience of sensory processing in different settings. Intervention studies are urgently needed to test whether sensory-enriched environmental redesign and staff training in sensory health can mitigate avoidance and sensitivity, thereby promoting well-being, functional independence, and, ultimately, a higher quality of life for institutionalized elderly people. For community-dwelling seniors, research should focus on identifying and mitigating factors that may shift adaptive Sensation Seeking toward maladaptive Low Registration or sensory isolation. Expanding this line of inquiry across diverse cultural and socioeconomic contexts will be essential to develop universally applicable, yet culturally sensitive, guidelines for supporting sensory health in aging populations.

5.4. Conclusions

This study demonstrates a strong association between the living environment and sensory processing patterns in older adults, as defined by Dunn's model. Institutionalized elders exhibited a profile marked by significantly higher sensory sensitivity and avoidance, whereas community-dwelling elders showed greater sensation seeking and low registration.

The results have direct and actionable implications for clinical practice and organizational policy in geriatric care:

- For institutional settings: there is an urgent need to shift from standardized to sensory-informed care environments. This includes implementing sensory screenings using tools such as the AASP upon admission, redesigning environments to provide zones of sensory respite and controlled stimulation, and mandating training for care staff to recognize and respond to sensory needs.

- For community-based and public health initiatives: policies should support sensory health promotion for aging in place by integrating sensory processing education into preventive geriatric health assessments, funding community programs that provide safe opportunities for sensory engagement, and developing guidelines for "sensory-friendly" public spaces.

In conclusion, acknowledging and addressing sensory processing patterns is a fundamental component of age-friendly policy and human-centered design. Tailoring environments and care approaches to sensory needs can enhance functional independence, reduce behavioral distress, and improve quality of life for older adults. Future work must focus on implementing and evaluating the efficacy of such sensory-based modifications in real-world care settings.

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Footnotes

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