

Article

Association of Sensorimotor Phenotypes with Mild Cognitive Impairment in Community-Dwelling Older Adults: A Cross-Sectional Study

Wildja de Lima Gomes ¹, Letícia Bojikian Calixtre ^{1,2}, Juliana Daniele de Araújo Silva ¹ ,
Gabriel Lucas Leite da Silva Santos ¹, Ruth Lahis da Silva Gonçalves ¹, Késia Moreira Sampaio Amaral ¹ ,
Francis Trombini-Souza ^{1,2} , Ana Carolina Rodarti Pitangui ^{1,2} and Rodrigo Cappato de Araújo ^{1,2,*} 

¹ Graduate Program of Rehabilitation and Functional Performance, University of Pernambuco (UPE), Petrolina 56328-900, PE, Brazil; wildja.gomes@upe.br (W.d.L.G.); leticia.calixtre@upe.br (L.B.C.); juliana.daniele@upe.br (J.D.d.A.S.); gabriel.lssantos@upe.br (G.L.L.d.S.S.); ruth.goncalves@upe.br (R.L.d.S.G.); kesia.sampaio@upe.br (K.M.S.A.); francis.trombini@upe.br (F.T.-S.); carolina.pitangui@upe.br (A.C.R.P.)

² Department of Physical Therapy, University of Pernambuco (UPE), Petrolina 56328-900, PE, Brazil

* Correspondence: rodrigo.cappato@upe.br

Abstract

Sensory and motor impairments have been independently associated with cognitive decline in older adults. However, less is known about the association between combined sensory and motor impairments and mild cognitive impairment (MCI). This study investigated the association between sensorimotor phenotypes and MCI in community-dwelling older adults. This cross-sectional study included 458 community-dwelling older adults. Sensory impairment was determined using a composite score based on visual acuity and auditory function. Motor impairment was assessed using the Short Physical Performance Battery. Participants were classified into four sensorimotor phenotypes: preserved function, sensory impairment, motor impairment, and dual impairment. MCI was identified using education-adjusted Montreal Cognitive Assessment cutoffs. Binary logistic regression models and receiver operating characteristic curve analyses were performed. Sensory impairment (OR = 2.21; 95%CI: 1.19–4.11), motor impairment (OR = 3.00; 95%CI: 1.12–8.06), and dual impairment (OR = 6.46; 95%CI: 3.14–13.28) were significantly associated with MCI in the fully adjusted model. The predictive model demonstrated moderate discriminatory ability (AUC = 0.750), with a sensitivity of 84.0% and specificity of 43.3%. Sensorimotor phenotypes were significantly associated with MCI. The coexistence of sensory and motor impairments showed the strongest association with MCI, suggesting that combined sensorimotor deficits may represent a clinically relevant marker of neurocognitive vulnerability in aging.

Keywords: cognitive dysfunction; sensory disorders; physical functional performance



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1. Introduction

Aging is a multisystemic process characterized by progressive biological changes in sensory, motor, and cognitive functions [1]. Hearing and visual deficits, as well as impaired physical performance, are common among older adults and have been associated with reduced functional capacity, loss of independence, and restricted social participation. Although these manifestations are common and often interpreted as part of natural aging, they may actually signal vulnerability and be associated with mild cognitive impairment (MCI) [2,3].

MCI represents an intermediate condition between expected cognitive aging and dementia, characterized by subtle cognitive deficits in domains such as memory, attention, and executive functions, without significant functional impairment [4]. Considering the potential for progression to dementia, the early identification of clinical factors associated with MCI has been considered an important aspect of research on aging and cognitive health [5,6].

Investigating the integration of sensory, motor, and cognitive domains may offer a more robust biological marker model to identify older adults at higher risk of developing MCI [7]. Longitudinal studies, such as the Maastricht Aging Study [8], show that multiple sensory deficits (impaired hearing and vision) increase the risk of cognitive decline, especially when present concomitantly. Possible mechanisms include reduced environmental stimulation, increased cognitive overload, and impaired sensory integration necessary for performing complex motor and cognitive tasks [9].

Similarly, impaired physical performance has been associated with poorer cognitive function [10]. Instruments such as the Short Physical Performance Battery (SPPB), which assesses balance, gait speed, and lower limb strength, reflect important aspects of mobility and functional reserve in older adults [11]. The study directly assessed the SPPB in 100 older adults with mild cognitive impairment, using its three components (balance, gait speed, and sit-to-stand test) as measures of physical performance. Evidence [12–14] demonstrates that motor impairment can occur in parallel with cognitive changes, sharing common neurodegenerative and vascular mechanisms.

In recent decades, evidence from aging research has shown that sensory and motor functions do not decline independently but exhibit substantial covariation and increasing interdependence with advancing age [15]. This covariation has been attributed to shared neurobiological mechanisms, including widespread alterations in cortico-subcortical networks and neuromodulatory systems that support sensory processing, motor control, and higher-order cognition [16]. Accordingly, the concept of sensorimotor function has emerged as an integrated construct that combines multiple sensory and motor indicators to more comprehensively capture the global integrity of systems responsible for the interaction between the body and the environment [16]. Recent studies in older adults have demonstrated that higher levels of sensorimotor function, operationalized through combined scores or latent constructs derived from visual, auditory, balance, gait, and strength measures, are robustly associated with lower odds of mild cognitive impairment and dementia, whereas the coexistence of sensory and motor deficits identifies individuals at increased risk of early cognitive impairment [7,15–18]. Therefore, considering an integrated “sensorimotor phenotype” rather than isolated sensory or motor impairments may provide a more informative framework to characterize cognitive risk profiles in aging and underpins the approach adopted in the present study.

Therefore, this study aimed to investigate the association between sensorimotor phenotypes and mild cognitive impairment among community-dwelling older adults. We hypothesized that individuals presenting concomitant sensory and motor impairments would have a higher likelihood of MCI than those without sensorimotor deficits.

2. Materials and Methods

2.1. Study Design

This cross-sectional observational study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations. This study is part of the Risk Factors for Aging (FREVO) project [19], developed at the Laboratory for Research in Health and Functional Performance—LABSED, University of Pernambuco, Brazil.

This study was approved by the Research Ethics Committee of the Amaury de Medeiros Integrated Health University Center (CISAM/UPE), under CAAE number 69901423.9.0000.5191, and all participants provided written informed consent before participation.

2.2. Participants

This study used data from the first wave of the FREVO cohort, conducted in 2024, which included 501 community-dwelling older adults. Participants were recruited through primary healthcare units, community centers, and local media advertisements.

Participants were eligible if they were aged 60 years or older, resided in the municipality of Petrolina, Pernambuco, Brazil, and were able to walk independently, with or without the use of an assistive device. Individuals with a previous diagnosis of dementia, disabling neurological disorders, severe decompensated cardiovascular disease, or any condition that precluded the completion of cognitive or physical assessments were excluded. Participants with missing data for the variables of interest were also excluded from the analyses.

2.3. Study Procedures

All assessments were conducted by previously trained researchers following the standardized FREVO study protocol [19]. After eligibility screening and informed consent, the participants completed a structured interview to obtain sociodemographic information, medical history, medication use, and lifestyle data. Subsequently, participants underwent a comprehensive assessment including cognitive, sensory, and physical performance measures.

2.4. Outcome: Cognitive Assessment

Global cognitive function was assessed using the Brazilian version of the Montreal Cognitive Assessment (MoCA) [20]. The MoCA is composed of eight cognitive domains: visuospatial/executive, naming, memory, attention, language, abstraction, delayed recall, and orientation. The total score ranges from 0 to 30 points, and for individuals with less than 12 years of schooling, it is recommended to add one point to the final score. The Brazilian version of the MoCA has shown acceptable accuracy for detecting MCI in validation studies; however, these estimates were derived from clinical samples and may not directly apply to community-based populations.

MCI was classified using education-adjusted cutoff scores validated for the Brazilian population: ≤ 8 points for illiterate individuals, ≤ 17 for those with 1–4 years of education, ≤ 19 for those with 5–11 years of education, and ≤ 21 for those with 12 or more years of education [21]. Because this was a community-based cross-sectional study, this classification should be interpreted as screening-defined MCI rather than a clinical diagnosis.

2.5. Exposure Variables

2.5.1. Physical and Functional Performance

Physical and functional performance was assessed using the Short Physical Performance Battery (SPPB). The SPPB consists of three tests: static balance, gait speed, and the chair sit-to-stand test. The total SPPB score ranges from 0 to 12, with scores of 10 or higher indicating good functional performance. The instrument has a sensitivity of 69% and a specificity of 84% for identifying functional limitations [22].

2.5.2. Sensory Function

Sensory impairment was determined using a composite score involving visual and auditory assessment.

Hearing ability was assessed using the whisper test [23], a widely used clinical screening tool for detecting possible hearing impairments in older adults. Participants were

seated while the examiner positioned themselves approximately one arm's length behind and to the side of the ear being tested. The contralateral ear was occluded by applying pressure to the tragus. The examiner then whispered four words and asked the participant to repeat them immediately. The procedure was performed bilaterally. Hearing function was considered preserved when participants correctly repeated at least three of the four whispered words in each ear. The whisper test has good accuracy for screening for hearing loss in adults, with a sensitivity of approximately 90% and specificity between 80% and 90% [24].

Visual function was assessed using a Snellen visual chart [25]. The Snellen chart consisted of rows of progressively smaller optotypes presented at a distance of three meters. Participants were instructed to identify the orientation of the optotypes, beginning with the largest symbols and progressing to smaller ones. Visual acuity was recorded according to the participant's best performance.

For the construction of the composite sensory score, visual acuity was classified as preserved (≥ 0.8 ; 2 points), mildly impaired ($0.4\text{--}0.7$; 1 point), or severely impaired (≤ 0.3 ; 0 points). Hearing function was classified as preserved (≥ 6 correctly identified words; 2 points), mildly impaired ($4\text{--}5$ words; 1 point), or severely impaired (≤ 3 words; 0 points) [26]. Scores from both assessments were summed up, generating a composite sensory score ranging from 0 to 4 points. Participants scoring < 3 points were classified as having sensory impairment.

Visual and hearing impairments were combined into a composite sensory classification following the standardized approach proposed by Lopez-Ortiz et al. [27] for operationalizing the sensory domain of intrinsic capacity. In this framework, visual and hearing functions are considered complementary components of the sensory domain and contribute equally to its overall classification. Accordingly, equal weighting was applied a priori to characterize participants' overall sensory status for sensorimotor phenotype classification rather than to develop a new diagnostic or psychometric index. This approach is consistent with current evidence indicating that no universally accepted weighting scheme exists for combining sensory impairments into a composite measure.

2.6. Classification of Sensorimotor Phenotypes

Participants were classified into four sensorimotor phenotypes: (1) Preserved functions: absence of sensory and motor impairment; (2) Sensory impairment: presence of isolated sensory impairment; (3) Motor impairment: presence of isolated motor impairment; (4) Dual impairment: concomitant presence of sensory and motor impairment.

2.7. Covariates

The following variables were considered as potential confounding factors and included in the adjusted models: sex, age, education level, race, body mass index (BMI), comorbidities, polypharmacy, level of physical activity, and depressive symptoms.

The variables age, sex, race, and education level were recorded using a questionnaire based on participant self-reporting. Body mass index (BMI) was calculated as the ratio between body mass (kg) and height squared (m^2). Comorbidities were assessed using the Charlson Comorbidity Index, a widely used instrument for estimating the burden of chronic diseases and mortality risk [28]. Polypharmacy was defined as the concomitant use of five or more medications [29].

Physical activity level was assessed using the short version of the International Physical Activity Questionnaire (IPAQ) [30]. Depressive symptoms were assessed using the Geriatric Depression Scale (GDS-15) [31].

2.8. Statistical Analysis

Statistical analyses were performed using JAMOV software (version 2.6). Initially, a descriptive analysis of the data was conducted. Continuous variables are presented as mean and standard deviation or median and interquartile range, according to the data distribution. Categorical variables are presented as absolute and percentage frequencies.

The association between sensorimotor phenotypes and the presence of mild cognitive impairment was investigated using binary logistic regression, with the group with preserved functions used as the reference category. The results are presented as odds ratios (ORs) and respective 95% confidence intervals (95% CIs). Sensorimotor phenotype was entered into the logistic regression model as a single categorical predictor with four predefined levels, using preserved function as the reference category. Accordingly, the reported odds ratios represent regression coefficients estimated within the same multivariable model rather than separate pairwise comparisons or post hoc tests.

Three regression models were constructed. Model 1 was performed without adjustments. Model 2 was adjusted for personal and sociodemographic variables, including sex, age, education, race, and body mass index (BMI). Model 3 was additionally adjusted for clinical and behavioral factors, including comorbidities using the Charlson Comorbidity Index, polypharmacy, smoking, alcohol consumption, physical activity level, and depressive symptoms. The goodness of fit of the models was assessed using the Akaike Information Criterion (AIC), with lower values indicating better relative fit among the models tested.

Additionally, predictive analysis was performed to evaluate the models' ability to correctly classify participants regarding the presence of mild cognitive impairment. Predictive performance was examined using the Receiver Operating Characteristic (ROC) classification matrix, accuracy, sensitivity, specificity, and area under the curve (AUC). For this analysis, a probability cutoff of 0.30 was selected based on ROC exploration because it provided the most suitable screening profile for the intended purpose of the model, with sensitivity prioritized over specificity [32]. Accordingly, a lower threshold than the conventional 0.50 was preferred to reduce the risk of false-negative classifications and improve case detection in a screening context [32,33]. The significance level adopted for all analyses was $p < 0.05$.

3. Results

Of the 501 participants assessed in the first wave of the FREVO study, 43 were excluded because of missing data in cognitive, sensory, motor, or covariate measures, resulting in a final analytical sample of 458 participants. Participants had a mean age of 70.6 ± 7.2 years, and 75.1% were women. The mean educational attainment was 8.9 ± 4.9 years, and the mean body mass index was 27.2 ± 4.7 kg/m². More than half of the sample met the criteria for mild cognitive impairment (52.0%). Participants presented a mean SPPB score of 9.9 ± 2.0 points and a mean MoCA score of 19.5 ± 5.4 points. Additional sociodemographic, lifestyle, and clinical characteristics are presented in Table 1.

Associations between sensorimotor phenotypes and MCI are presented in Table 2. In the fully adjusted model, participants classified as having sensory impairment exhibited 2.21-fold higher odds of MCI (OR = 2.21; 95% CI: 1.19–4.11). Similarly, motor impairment was associated with 3.00-fold higher odds of MCI (OR = 3.00; 95% CI: 1.12–8.06). The strongest association was observed for dual impairment, which was associated with 6.46-fold higher odds of MCI (OR = 6.46; 95% CI: 3.14–13.28) compared with individuals with preserved function.

Table 1. Sociodemographic, lifestyle, and clinical characteristics of the 458 study participants.

Features	Continuous Variables Mean $\pm$ SD	Categorical Variables n (%)
Age	70.58 $\pm$ 7.17	-
Sex	-	-
Female	-	344 (75%)
Male	-	114 (25%)
Weight (kg)	67.38 $\pm$ 13.09	-
Height (m)	1.57 $\pm$ 0.08	-
BMI	27.19 $\pm$ 4.70	-
BMI, Categories	-	-
Eutrophic	-	162 (35.4%)
Overweight	-	187 (40.8%)
Obesity	-	109 (23.8%)
Race,	-	-
White	-	134 (29.3%)
Black	-	59 (12.9%)
Brown	-	236 (51.5%)
Yellow	-	20 (4.4%)
Indigenous people	-	9 (1.9%)
Education (years)	8.91 $\pm$ 4.89	-
Level of Physical Activity	-	-
Sedentary	-	84 (18.3%)
Irregularly active	-	152 (33.2%)
Active	-	183 (40%)
Very active	-	39 (8.5%)
Polypharmacy	-	-
Yes	-	101 (22.1%)
No	-	357 (77.9%)
Charlson Index	2.51 (1.83)	-
Depression (GDS-15)	3.07 (2.73)	-
SPPB	9.85 (2.01)	-
MoCA	19.49 (5.44)	-
Mild Cognitive Impairment (MCI), n(%)	-	-
Yes	-	238 (52%)
No	-	220 (48%)
Visual function (Snellen)	0.72 (0.24)	-
Auditory function (Whisper test)	5.59 (2.41)	-

BMI—Body Mass Index, SPPB—Short Physical Performance Battery, MoCA—Montreal Cognitive Assessment, GDS—Geriatric Depression Scale.

Table 2. Association between sensorimotor phenotypes and the presence of mild cognitive impairment (MCI).

Sensorimotor Phenotype	Model 1		Model 2		Model 3	
	OR (95%CI)	<i>p</i>	OR (95%CI)	<i>p</i>	OR (95%CI)	<i>p</i>
Sensory Impairment	1.85 (1.11–3.07)	0.018	1.89 (1.09–3.27)	0.023	2.21 (1.19–4.11)	0.012
Motor Impairment	2.17 (0.98–4.81)	0.056	2.18 (0.95 to 5.05)	0.067	3.00 (1.12–8.06)	0.029
Dual Impairment	4.89 (2.82–8.50)	<0.001	4.78 (2.59–8.82)	<0.001	6.46 (3.14–13.28)	<0.001
	AIC = 568.960		AIC = 517.000		AIC = 459.426	

Model 1—No adjustment. Model 2—Adjusted for age, sex, education, race, BMI. Model 3—Adjusted for age, sex, education, race, BMI, physical activity level, comorbidities, depressive symptoms, polypharmacy.

Model fit improved across the sequential adjustment process. The fully adjusted model presented the lowest Akaike Information Criterion (AIC) value, indicating superior relative fit compared with the unadjusted and partially adjusted models.

Predictive analysis of the fully adjusted model demonstrated moderate discriminative ability for identifying participants with MCI, presenting an area under the ROC curve (AUC) of 0.750. Using a probability cutoff point of 0.30, the model showed a sensitivity of 84.0%, specificity of 43.3%, and overall accuracy of 61.0%. These findings indicate that the model was more effective in identifying individuals with MCI than in excluding those without the condition.

4. Discussion

The present study demonstrated significant associations between sensorimotor phenotypes and MCI among community-dwelling older adults. As hypothesized, the coexistence of sensory and motor impairments showed the strongest association with MCI, even after adjusting for confounding factors. Furthermore, both isolated sensory and motor impairments remained independently associated with MCI, suggesting that alterations across different systems may contribute to cognitive vulnerability. Additionally, the predictive model showed high sensitivity for identifying participants with MCI, reinforcing the potential of simple sensory function and physical performance assessments as low-cost screening strategies in primary health care settings.

The main finding of this study was the strong association between dual sensorimotor impairment and MCI. This result suggests that the coexistence of deficits across multiple physiological systems may represent a sensitive clinical marker of cognitive vulnerability in aging. Simultaneous sensory and motor impairments may reflect reduced physiological reserve and diminished resilience to age-related stressors, characteristics that have been linked to accelerated biological aging and increased susceptibility to neurodegenerative processes. This interpretation is consistent with recent evidence indicating that the accumulation of deficits in multiple systems is associated with worse cognitive outcomes and a higher risk of dementia [15,17].

Longitudinal studies have demonstrated robust associations between sensorimotor impairments and cognitive health. In a cohort of Medicare beneficiaries followed for up to 11 years, Davoudi et al. [34] observed that visual impairments and multiple motor deficits were independently associated with the incidence of dementia, with the risk increasing progressively according to the number of sensorimotor deficits present. Similarly, Wanigatunga et al. [15] found that better performance on an integrated construct of sensorimotor function was associated with lower odds of mild cognitive impairment in two large North American cohorts. Convergent results were observed by Sayyid et al. [17], who demonstrated that better multisensory and motor function was associated with a lower risk of early cognitive impairment, while the DRIVES Project [18] identified sensorimotor function as a potential early marker of cognitive decline and burden of biomarkers related to Alzheimer's disease.

Taken together, these findings suggest that the combination of sensory and motor deficits may represent more than the simple sum of isolated impairments. The stronger association observed among participants with dual impairment supports the hypothesis that the accumulation of deficits across different systems exerts additive or even synergistic effects on cognitive health, reflecting a clinical phenotype of accelerated aging and increased neurofunctional vulnerability.

Nonetheless, it is important to acknowledge that the directionality of these associations is likely complex and potentially bidirectional. MCI may itself lead to reduced physical activity, slower gait, and less engagement in stimulating sensory environments [35]. Longitudinal studies have suggested reciprocal relationships between cognition and movement behaviors, often with stronger effects from cognition to subsequent physical activity, and declining memory trajectories have been linked to increases in sedentary time and decreases in light activity among older adults [36,37]. Similarly, cognitive impairment may reduce

participation in social and environmental contexts that provide multisensory stimulation, potentially reinforcing both sensory and motor deficits [38]. Given the cross-sectional design of the present study, we cannot disentangle whether sensorimotor impairments precede and contribute to MCI, whether emerging MCI leads to changes in sensorimotor function, or whether both processes co-occur within a broader cycle of declining brain and functional health; future longitudinal and interventional studies will be essential to clarify these temporal pathways.

The results of this study also demonstrated that sensory impairment was independently associated with MCI, even after adjusting for sociodemographic, clinical, and behavioral factors. This finding corroborates consistent evidence that auditory and visual impairments constitute important markers of cognitive vulnerability in aging [34]. A recent systematic review and meta-analysis demonstrated that dual auditory, visual, and sensory deficits are associated with a higher likelihood of cognitive impairment and dementia, with the strongest associations observed among individuals with concurrent deficits in both sensory modalities [39].

Similarly, Fuller-Thomson et al. [40], in a population analysis involving more than five million older adults, reported that individuals with concomitant hearing and vision impairment were approximately eight times more likely to have cognitive impairment compared to those without sensory deficits. Additionally, Tomida et al. [41] found that dual sensory impairment was associated not only with the presence of mild cognitive impairment, but also with poorer performance in executive functions, attention, and processing speed.

Overall, these findings suggest a possible cumulative association of sensory deficits with cognitive health. Among the mechanisms proposed to explain this association, the cognitive overload hypothesis stands out, according to which individuals with sensory impairments need to mobilize a greater amount of cognitive resources to interpret environmental stimuli, reducing the availability of these resources for higher cognitive functions, such as memory, attention, and executive functions. Furthermore, sensory deficits and cognitive impairment share biological mechanisms related to aging, including neurodegenerative, vascular, and inflammatory changes [42]. Auditory and visual impairments may also indirectly contribute to cognitive vulnerability through reduced social participation, decreased physical activity, and increased depressive symptoms [42]. Considering that sensory deficits often remain underdiagnosed and are potentially treatable, their early identification may represent an important opportunity for screening and prevention strategies for cognitive impairment in older adults.

Motor impairment was also associated with MCI after adjusting for sociodemographic, clinical, and behavioral factors. This finding reinforces evidence that alterations in physical performance represent important markers of neurocognitive vulnerability in aging. A systematic review and meta-analysis conducted by Kueper et al. [43] demonstrated that poorer motor performance, particularly in measures of gait and balance, is associated with a higher risk of dementia. Likewise, Peel et al. [44] observed that individuals with mild cognitive impairment and dementia exhibit clinically relevant reductions in gait speed when compared to cognitively preserved individuals, while recent longitudinal studies suggest a bidirectional relationship between cognitive decline and motor performance throughout aging [44].

Although gait speed is often considered one of the most robust motor markers of brain health, the present study used the SPPB, a multidimensional measure that incorporates components of balance, mobility, and muscle strength. Thus, our findings suggest that cognitive impairment may be related not only to reduced mobility but also to a broader decline in physical capacity. Potential mechanisms include alterations in neural networks

shared between motor control and cognition, especially those related to executive functions, attention, and motor planning. Furthermore, reduced physical performance may lead to less engagement in social and physical activities, contributing to a cycle of functional and cognitive decline [44]. Taken together, these results reinforce the importance of assessing physical performance as a component of cognitive vulnerability screening strategies in older adults.

Beyond the observed associations, the predictive model showed moderate discriminative capacity for identifying participants with mild cognitive impairment, with high sensitivity. Although specificity was modest, this profile is compatible with population screening strategies, in which the early identification of potentially vulnerable individuals is prioritized over diagnostic confirmation. In this context, the findings have important clinical applicability, especially in primary health care, since sensorimotor phenotypes were identified using simple, low-cost, and widely available instruments, such as the whisper test, visual acuity assessment, and the SPPB. Considering the growth of the elderly population and the need for feasible strategies for early detection of cognitive impairment, the incorporation of sensory and physical performance assessments can contribute to the identification of individuals with a higher chance of MCI and guide more in-depth cognitive assessments when necessary. Furthermore, because sensory and motor impairments are potentially modifiable conditions, their identification may support individualized preventive strategies, such as hearing and vision optimization, exercise programs, and closer clinical follow-up. Although the present findings do not establish that such interventions prevent cognitive decline, early recognition of these impairments may provide an opportunity to implement evidence-based strategies aimed at maintaining functional health and monitoring cognitive status over time.

Several limitations should be considered when interpreting the results. Firstly, the cross-sectional design prevents establishing temporal or causal relationships between sensorimotor phenotypes and mild cognitive impairment. Furthermore, auditory and visual functions were assessed using clinical screening instruments, not specialized diagnostic tests, although such instruments have good applicability in population and primary care settings. Moreover, the diagnostic accuracy of the Brazilian MoCA cutoffs was originally estimated in clinical samples, and their performance may differ in community-based populations with heterogeneous educational backgrounds. The sample was predominantly composed of women and drawn from a single municipality in northeastern Brazil, which may reflect differential participation patterns in community-based aging studies and limit the generalizability of the findings to older men, other Brazilian regions, and international populations. Because no comparison between included and excluded participants was performed, selection bias cannot be completely ruled out. Another limitation should be considered regarding the operationalization of the sensory domain. Although the composite sensory classification adopted in this study was based on the standardized framework proposed for assessing the sensory domain of intrinsic capacity, this approach should be regarded as a pragmatic method for phenotype classification rather than a validated diagnostic or psychometric index. At present, there is no universally accepted method for combining visual and hearing impairments into a single composite measure, and the equal weighting assigned to both sensory modalities reflects the absence of an established weighting scheme rather than evidence that they contribute equally to cognitive vulnerability. Future studies should investigate alternative approaches for constructing and validating composite sensory measures in different populations.

Despite these limitations, the study makes a relevant contribution by demonstrating that the combination of simple assessments of sensory function and physical performance can identify older adults with a higher likelihood of mild cognitive impairment. Future

longitudinal studies are needed to investigate whether sensorimotor phenotypes are associated with the progression of cognitive impairment, the development of dementia, and other adverse age-related outcomes, as well as to validate their use in different clinical and population contexts.

5. Conclusions

Sensorimotor phenotypes were significantly associated with screening-defined MCI in community-dwelling older adults. Participants with dual sensorimotor impairment exhibited the strongest association with MCI, followed by those with isolated sensory and motor impairments. Furthermore, a model based on simple sensory and physical performance assessments demonstrated good sensitivity, supporting the potential clinical utility of these measures as pragmatic screening tools to identify older adults with a higher likelihood of MCI in primary health care settings. These findings should be interpreted as evidence of association rather than causation, and longitudinal studies are needed to determine whether sensorimotor phenotypes predict future cognitive decline and other adverse aging outcomes.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical restrictions related to the protection of participant confidentiality.

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Abbreviations

The following abbreviations are used in this manuscript:

MCI	Mild Cognitive Impairment
MoCA	Montreal Cognitive Assessment
SPPB	Short Physical Performance Battery
GDS	Geriatric Depression Scale

BMI	Body Mass Index
OR	Odds Ratio
95%CI	95% Confidence Interval

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