# Visuomotor integration as a key predictor of motor coordination in frail elderly: functional dissociation and psychometric collapse in cognitive impairment

*Integración visuomotora como predictor clave de la coordinación motora en mayores frágiles: disociación funcional y colapso psicométrico en deterioro cognitivo*

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## Abstract

Objective: The present study analyzed visuomotor competencies in institutionalized older adults and evaluated the potential impact of an eight-week multicomponent intervention on these skills across different cognitive profiles.
Method: A quasi-experimental single-group design with pre- and post-test measures was employed with an initial sample of 58 participants recruited from residential care facilities. The baseline assessment included 38 individuals with cognitive impairment (CI) and 20 without impairment (NCI), while the post-intervention phase was completed by 26 participants with CI and 16 with NCI due to clinical attrition. The intervention consisted of a combined physical and cognitive stimulation program three times per week. Visuomotor integration, visual perception, and motor coordination were assessed using the Beery-Buktenica Developmental Test of Visuomotor Integration (VMI) and its standardized subtests.
Results: The baseline analysis suggests that visuomotor integration capacity might act as the sole relevant predictor of motor coordination in this population. Post-intervention data suggest no significant gains in motor coordination; specifically, the CI group exhibited a floor effect, while the NCI group showed a slight decline in performance.
Conclusions: These findings suggest that low-frequency training was insufficient to promote the transfer of fine motor skills. The results indicate that preserving dexterity in frail older adults might require more specific interventions with a higher dosage of practice. Furthermore, current standardized tools may lack the psychometric sensitivity required to evaluate advanced cognitive impairment in residential settings.

## Keywords

Cognitive impairment; fine motor skills; institutionalization; multicomponent exercise; visuomotor integration.

## Resumen

Objetivo: El presente estudio analizó las competencias visuomotoras en adultos mayores institucionalizados y evaluó el impacto potencial de una intervención multicomponente de ocho semanas sobre estas habilidades en función de diferentes perfiles cognitivos.
Método: Se empleó un diseño cuasiexperimental de grupo único con medidas pre y post-test en una muestra inicial de 58 participantes reclutados en centros residenciales. La evaluación inicial incluyó a 38 individuos con deterioro cognitivo (CI) y 20 sin deterioro (NCI), mientras que la fase post-intervención contó con 26 participantes con CI y 16 con NCI debido a la atrición clínica. La intervención consistió en un programa de estimulación física y cognitiva tres veces por semana. Se evaluó la integración visuomotora, percepción visual y coordinación motora mediante el test Beery-Buktenica (VMI) y sus subtests estandarizados.
Resultados: El análisis inicial sugiere que la capacidad de integración visuomotora podría actuar como el único predictor relevante de la coordinación motora en esta población. Los datos post-intervención no sugieren mejoras significativas en la coordinación; específicamente, el grupo con CI mostró un efecto suelo, mientras que el grupo NCI presentó un ligero descenso en el rendimiento.
Conclusiones: Los hallazgos sugieren que el entrenamiento de baja frecuencia fue insuficiente para promover la transferencia de habilidades motoras finas. Los resultados indican que preservar la destreza en mayores frágiles podría requerir intervenciones más específicas y con una mayor dosis de práctica. Asimismo, se evidencia la necesidad de utilizar herramientas de evaluación con mayor sensibilidad psicométrica para el deterioro cognitivo avanzado en contextos residenciales.

## Palabras clave

Deterioro cognitivo; ejercicio multicomponente; habilidades motoras finas; institucionalización; integración visuomotora.

## Introduction

Global demographic aging represents a critical challenge of the 21st century, entailing an increasing prevalence of neurodegenerative diseases and functional disabilities (Steinmetz et al., 2024). Institutionalization frequently follows this trend, providing basic care but often associating it with high levels of sedentary behavior and sensory deprivation (World Health Organization, 2015). Current scientific literature suggests that institutionalization accelerates the decline of functional and cognitive competencies, creating a cycle of dependency and frailty (Lopes et al., 2021). There is also a strong association between physical and cognitive health; institutionalized frail older adults face a higher risk of falls, hospitalizations, and disabilities (Gao et al., 2025; Kozak-Szkopek et al., 2025).

The coexistence of frailty and cognitive impairment is prevalent in long-term care settings, where both factors correlate with worse functional performance (Aprahamian et al., 2009; Shulman, 2000). Research highlights that functional decline in daily activities is progressive following admission, especially among residents with high baseline dependency (Palese et al., 2016). In this scenario, visuomotor skills (the ability to synchronize visual perception with motor movement), assume a pivotal role in maintaining autonomy and ensuring the integrity of fine motor tasks like handwriting (De Vita et al., 2021). Deficits in this integration directly impact independence and are often linked to neurodevelopmental or aging-related decline (Li et al., 2021; Rao et al., 2021). Recent studies emphasize that physical activity programs in residential facilities must be meticulously designed to address these specific functional needs to effectively improve quality of life (Concha-Cisternas et al., 2025).

The integrity of these competencies depends on a complex neural network involving the visual cortex and frontal lobes, areas frequently affected by aging and cognitive impairment (Li et al., 2018). Recent studies indicate that alterations in gait or eye-hand coordination may serve as early biomarkers of neurodegenerative pathology (Montero-Odasso et al., 2019). While multicomponent physical exercise (combining strength, balance, and aerobic training) is the gold standard for mitigating functional decline (Chodzko-Zajko et al., 2009; Izquierdo et al., 2021), its specific efficacy in maintaining visuomotor skills requires further investigation. Evidence suggests that such programs can improve executive function (Hillman et al., 2008), yet gains in global motor function do not automatically translate into manual dexterity (Gaviria et al., 2025). It is imperative to question whether current generalist protocols are sufficient to induce significant neuromuscular adaptations in individuals with cognitive deficits (Castellote-Caballero et al., 2024; Gheysen et al., 2018).

Therefore, this investigation aims to bridge this gap by analyzing visuomotor competencies in institutionalized older adults with and without cognitive impairment before and after an eight-week multicomponent intervention (Folstein et al., 1975; Santana et al., 2016). Based on the identified clinical needs and the necessity for accurate screening, the following operative and measurable hypotheses are formulated:

1. An eight-week program will result in measurable maintenance of visuomotor scores in cognitively healthy participants, while those with cognitive impairment will show resistance to change.

2. Baseline visuomotor integration capacity will act as the primary statistical predictor of motor coordination performance.

3. Conventional assessment instruments, such as the VMI, will demonstrate a lack of sensitivity (floor effect) in participants with advanced cognitive impairment, limiting their clinical utility in advanced frailty (Beery & Beery, 2006; Strauss et al., 2006).

## Method

The research adopted a quasi-experimental pre-test/post-test design without a passive control group to evaluate the impact of a multicomponent exercise program on visuomotor skills. The study was explanatory and correlational in scope, aiming to identify adaptation patterns and potential differences based on cognitive profiles in an institutional context. Due to ethical and logistical reasons inherent to the nursing home setting, the decision was made not to exclude eligible residents from the potential benefits of physical activity; thus, the group without cognitive impairment served as a comparative control for the cognitive status variable rather than for the experimental condition per se, which limits the ability to establish definitive causal inferences.

## *Participants*

The study involved institutionalized older adults, stratified by cognitive status. A total of 58 participants were initially recruited, consisting of 38 individuals with cognitive impairment (CI) and 20 cognitively unimpaired controls (NCI). The mean age of the CI group was 86.05 years (SD = 6.26), whereas the NCI group had a mean age of 84.35 years (SD = 7.78). Inclusion in the CI group required medical documentation of cognitive impairment, a Mini-Mental State Examination (MMSE) score below education-adjusted thresholds, and a Clock Drawing Test score ≤ 6. The NCI group consisted of residents institutionalized for non-cognitive reasons who achieved MMSE and Clock Drawing Test scores above the cut-off values. Exclusion criteria included a history of neurological conditions (e.g., stroke), psychiatric disorders, or inability to perform written tasks. The final sample for the second phase comprised 42 participants (26 CI and 16 NCI) following a non-probabilistic recruitment process during the follow-up period and considering attrition caused by mortality or hospitalization.

## *Procedure*

The Évora University research ethics committee approved all procedures (GD 24725/2023), and participants provided informed consent. Assessments were conducted during the week prior to the start of the intervention and repeated in the week immediately following its conclusion. The "Mind in Motion" intervention program lasted for eight consecutive weeks, comprising three 30-minute sessions per week. The protocol was organized into two mesocycles. The first mesocycle (weeks 1–4) focused on retrieving fundamental competencies such as functional mobility and global coordination, while the second mesocycle (weeks 5–8) aimed to refine visuomotor competencies essential for handwriting through fine motor control tasks and cognitive challenges. In accordance with current exercise guidelines for frail populations (Concha-Cisternas et al., 2025), participants rotated through stations designed to stimulate manual dexterity (e.g., threading beads, modeling clay) and eye-hand coordination. Attendance was recorded, and only participants with at least 75% adherence were included in the final analysis.

Table 1. Weekly distribution of specific objectives and examples of exercises by mesocycle

| Program phase | Weekly Session | Specific Objectives (Main Focus) | Examples of Integrated Exercises |
|---|---|---|---|
| Mesocycle 1 (weeks 1–4) Adaptation phase | Monday (Global Motor Focus) | Improve functional mobility, static/dynamic balance, and global coordination. | Walking in a straight line; chair stand; single-leg balance with support; stepping over small obstacles. |
| | Wednesday (Fine Motor Focus) | Stimulate grip, basic manual dexterity, and object manipulation. | Squeezing clothespins of different resistances; molding simple shapes with modeling clay; transferring beans/beads. |
| | Friday (Simple Dual Task) | Introduce light cognitive stimulation associated with movement. | Walking with countdowns; passing a ball while naming colors; spatial orientation (up/down/left/right). |
| Mesocycle 2 (weeks 5–8) Refinement phase | Monday (Complex Coordination) | Increase the complexity of motor sequences and movement precision. | Building 3D structures with straws; walking circuits with direction changes upon visual signal. |
| | Wednesday (Fine Visuomotor Focus) | Refine eye-hand coordination and fine pincer movements (writing support). | Threading beads onto strings of different gauges; creating letters with modeling clay; precision fitting games. |

| | | |
|---|---|---|
| Friday<br><br>(Complex Dual Task) | Enhance working memory, cognitive flexibility, and multi-step instructions. | Visual memory games with cards; reproduction of rhythmic sequences; visual discrimination tasks under time pressure. |

*Instrument*

Visuomotor skills were assessed using the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI), 5th Edition, including the main test and two standardized supplemental tests. The Beery VMI test required participants to copy a sequence of 30 geometric shapes, with scoring based on correct reproduction until a ceiling of three consecutive failures was reached. The Visual Perception supplemental test assessed visual discrimination capacity within a three-minute limit, scoring one point for each correct match identified. The Motor Coordination supplemental test evaluated fine motor control by requiring the tracing of shapes within delimited paths within a five-minute limit. Raw scores were converted into standard scores using the normative tables provided in the manual. Cognitive characterization was performed using the MMSE and the Clock Drawing Test.

### *Data analysis*

Statistical data analysis was performed using IBM SPSS Statistics software (version 30.0). A descriptive analysis characterized the sample using measures of central tendency and dispersion. Normality was assessed using the Shapiro-Wilk test, which indicated a violation of the normality assumptions; therefore, nonparametric statistics were employed. Differences between groups were analyzed using the Mann-Whitney U test, while intra-group changes were evaluated using the Wilcoxon signed-rank test. Effect sizes (r) were calculated using Rosenthal's formula ($r = Z / \sqrt{N}$) (Rosenthal, 1991). Linear regression analysis was conducted to identify potential predictors of motor coordination. The significance level was set at $p < 0.05$.

## Results

The assessment of visuomotor skills was operationalized using the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI), complemented by the standardized tests of Visual Perception and Motor Coordination. The analysis compared measurements taken before and after the intervention between two distinct groups: the cognitive impairment group (CI) and the cognitively healthy group (NCI).

### *Group Comparisons and Intra-group Evolution*

Regarding Visuomotor Integration, no statistically significant differences were verified between the group with suspected cognitive deficit (CI) and the group without suspicion (NCI) at either the pre-intervention ($U = 304$; $p = .079$; 95% CI of the difference [-4.77, 0.39]) or post-intervention ($U = 161$; $p = .086$; 95% CI of the difference [-0.88, 0.12]). The effect size remained small at both moments. Statistically significant differences were verified between the groups in Visual Perception at both assessment moments: pre ($U = 213$; $p = .004$) and post ($U = 98$; $p = .008$), with a moderate effect size. In terms of intra-group evolution, the NCI group showed a statistically significant decline in VMI performance ($p = .042$) with a very large effect size ($r = 0.91$). In the CI group, no significant change in VMI scores was observed ($p = .109$). Regarding Motor Coordination, neither group showed significant changes between the pre- and post-test. Post-intervention analysis revealed that 100% ($n = 26$) of the CI group participants reached the minimum score (45) on the VMI test. Regarding Motor Coordination in the post-test, 84.6% ($n = 22$) of the CI group scored at the lower limit of the scale. Notably, in the CI group, the effect size for Motor Coordination could not be calculated because of the high prevalence of ties in the ranked data, due to a floor effect. The summary of these statistical comparisons is presented in Table 2.

Table 2. Summary of statistical comparisons for between-group and within-group analyses

| Group / Comparison | Condition (Test) | M (SD) | 95% CI [Means] | 95% CI [Difference] | Statistic (U / W) | p-value | R | Magnitude |
|---|---|---|---|---|---|---|---|---|
| CI (38) vs NCI (20) | VMI Total (Pre) | 47.71 (±8.13) vs 49.90 (±8.69) | [45.1, 50.3] vs [46.1, 53.7] | [-4.77, 0.39] | 304 | .079 | 0.23 | Small |
| CI (26) vs NCI (16) | VMI Total (Post) | 45.00 (±0.00) vs 45.38 (±1.03) | [45.0, 45.0] vs [44.8, 45.9] | [-0.88, 0.12] | 161 | .086 | 0.28 | Small |
| CI (38) vs NCI (20) | Vis. Perc. (Pre) | 56.16 (±17.38) vs 70.20 (±19.05) | [50.6, 61.7] vs [61.9, 78.5] | [-23.6, -4.41] | 213 | .004 | 0.38 | Moderate |
| CI (26) vs NCI (16) | Vis. Perc. (Post) | 53.91 (±14.74) vs 72.25 (±24.65) | [48.3, 59.5] vs [60.2, 84.3] | [-30.4, -6.18] | 98 | .008 | 0.42 | Moderate |
| CI (38) vs NCI (20) | Mot. Coord. (Pre) | 48.66 (±7.91) vs 56.40 (±15.52) | [46.1, 51.2] vs [49.6, 63.2] | [-14.5, -0.92] | 275 | .033 | 0.28 | Small |
| CI (26) vs NCI (16) | Mot. Coord. (Post) | 46.61 (±5.58) vs 52.50 (±12.55) | [44.5, 48.7] vs [46.4, 58.6] | [-11.9, 0.16] | 140 | .060 | 0.30 | Moderate |
| CI (26) (Pre vs Post) | VMI Total | 47.71 (±8.13) vs 45.00 (±0.00) | [45.1, 50.3] vs [45.0, 45.0] | [-0.38, 5.81] | 0 | .109 | 0.92 | Large |
| NCI (16) (Pre vs Post) | VMI Total | 49.90 (±8.69) vs 45.38 (±1.03) | [45.6, 54.2] vs [44.8, 45.9] | [0.17, 8.87] | 0 | .042 | 0.91 | Large |

Note: CI (Cognitive Impairment); NCI (Non-Cognitive Impairment); 95% CI [Means] represents the confidence interval for the mean of each group; 95% CI [Difference] represents the confidence interval for the difference between the compared means.

## *Correlation Analysis*

Spearman correlation analysis revealed distinct patterns of association between the groups at the initial assessment. In the CI group, only a moderate and statistically significant positive correlation was observed between Visuomotor Integration (VMI) and Motor Coordination (rs = .58; p < .01; 95% CI [.32, .76]), whereas the correlation between VMI and Visual Perception was not significant (rs = .24; 95% CI [-.09, .52]). In contrast, in the NCI group, significant positive correlations were found between all variables: VMI and Visual Perception (rs = .54; p < .05; 95% CI [.13, .79]), VMI and Motor Coordination (rs = .54; p < .05; 95% CI [.13, .79]), and Visual Perception and Motor Coordination (rs = .51; p < .05; 95% CI [.08, .77]). At the second assessment, correlations involving VMI in the CI group could not be computed because of the ceiling effect (100% floor). In the NCI group at the second assessment, only the association between VMI and Visual Perception remained significant (rs = .56; p < .05; 95% CI [.15, .81]), while Motor Coordination no longer showed significant correlations with VMI (rs = .10; 95% CI [-.42, .56]) or Visual Perception (rs = .27; 95% CI [-.26, .67]).

Table 3. Summary of statistical comparisons for correlation analyses between CI and NCI groups and by pre- and post-intervention phases, among VMI Total, Visual Perception Test, and Motor Coordination.

| Group / Assessment | Variables | 1. VMI | 2. Visual Perception | 3. Motor Coordination |
|---|---|---|---|---|
| 1st Assessment (CI) | 1. VMI | — | 0.24 [-.09, .52] | 0.58** [.32, .76] |
| | 2. Visual Perception | 0.24 [-.09, .52] | — | 0.07 [-.26, .38] |
| | 3. Motor Coordination | 0.58** [.32, .76] | 0.07 [-.26, .38] | — |
| 1st Assessment (NCI) | 1. VMI | — | 0.54* [.13, .79] | 0.54* [.13, .79] |
| | 2. Visual Perception | 0.54* [.13, .79] | — | 0.51* [.08, .77] |
| | 3. Motor Coordination | 0.54* [.13, .79] | 0.51* [.08, .77] | — |
| 2nd Assessment (CI) | 1. VMI | — | a | a |
| | 2. Visual Perception | a | — | 0.20 [-.21, .55] |
| | 3. Motor Coordination | a | 0.20 [-.21, .55] | — |
| 2nd Assessment (NCI) | 1. VMI | — | 0.56* [.15, .81] | 0.10 [-.42, .56] |
| | 2. Visual Perception | 0.56* [.15, .81] | — | 0.27 [-.26, .67] |
| | 3. Motor Coordination | 0.10 [-.42, .56] | 0.27 [-.26, .67] | — |

Note: Values in brackets represent the 95% Confidence Interval. * p< .05. ** p<.01. ^a Correlation cannot be computed due to 100% floor effect (variance = 0) in the CI group.

## *Linear Regression Analysis*

To understand the impact of visual and integrative components on motor performance, a linear regression analysis was conducted. In the first assessment of the CI group, the model explained 45.4% of the variance in Motor Coordination ($R^2$ = .454), with the VMI total score being the only statistically significant predictor (β = .695; p < .001; 95% CI [.44, .95]). Visual Perception did not demonstrate significant predictive power. Similarly, in the NCI group at the first assessment, the model explained 44.5% of the variance ($R^2$ = .445), with VMI again emerging as a significant predictor (β = .451; p = .035; 95% CI [.04,

.86]). In the second assessment, the regression models lost statistical validity in both groups. This outcome reflects the absence of variance in the CI group due to the 100% floor effect and the dissociation of competencies observed in the NCI group, as evidenced by the non-significant predictors and the negative adjusted R2 in the NCI group post-test.

Table 4. Linear Regression Analysis: VMI and Visual Perception as predictors of Motor Coordination.

| Group | Time Point | Predictor Variables | Beta (β) | 95% CI for β | t | p | $R^2$ |
|---|---|---|---|---|---|---|---|
| CI | 1st Assessment | VMI Total | 0.695 | [0.44, 0.95] | 5.462 | <.001 | 0.454 |
| | | Visual Perception | 0.002 | [-0.25, 0.26] | 0.012 | .990 | |
| CI | 2nd Assessment | VMI Total | —* | —* | —* | —* | —* |
| | | Visual Perception | -0.182 | [-0.63, 0.26] | -0.849 | .405 | |
| NCI | 1st Assessment | VMI Total | 0.451 | [0.04, 0.86] | 2.294 | .035 | 0.445 |
| | | Visual Perception | 0.368 | [-0.04, 0.78] | 1.873 | .078 | |
| NCI | 2nd Assessment | VMI Total | -0.065 | [-0.88, 0.75] | -0.174 | .864 | -0.079 |
| | | Visual Perception | 0.295 | [-0.51, 1.10] | 0.795 | .441 | |

Note: CI (Cognitive Impairment); NCI (Non-Cognitive Impairment); 95% CI = 95% Confidence Interval for Beta. *VMI is constant (45.00) in the CI group due to the 100% floor effect, preventing its inclusion in the regression model.

## Discussion

The present study analyzes the dynamics of visuomotor competencies in institutionalized older adults, stratified by cognitive profile, and evaluates the response of these variables to a multicomponent exercise program. The findings suggest that cognitive status may not only influence performance levels but also alter how visual and motor systems interact.

### *Predictors of Motor Coordination and the Role of Integration*

The linear regression analysis suggests a relevant finding for understanding fine motor skills in geriatrics: Visuomotor Integration (VMI) capacity appears to emerge as the sole statistically significant predictor of Motor Coordination, explaining approximately 45% of the variance in both groups at the baseline assessment ($R^2 \approx 0.45$). In contrast, Visual Perception does not demonstrate statistically significant predictive capacity. This result could support the hypothesis that effective motor execution (e.g., writing and object manipulation) depends less on visual discriminative acuity (the "seeing") and more on the efficiency of the processes responsible for translating visual input into motor output. This interpretation appears to align with models suggesting that integration mechanisms are more determinant for motor action than isolated visual recognition in graphomotor tasks (Li et al., 2018; Rao et al., 2021). From a clinical perspective, these data suggest that motor coordination rehabilitation should possibly prioritize exercises that stimulate perception-action coupling.

### *Functional Dissociation and Cognitive Decline*

The correlation analysis (Table 3) appears to expose a fracture in the functional coherence of the cognitive impairment (CI) group. While the healthy group (NCI) initially presents an integrated system, the CI group exhibits a disconnect between the visual and motor domains. This fragmentation suggests that cognitive decline may be associated with reduced inter-functional area communication efficiency (Gao et al., 2025; Li et al., 2018; Montero-Odasso et al., 2019). The decline observed in the NCI group after the intervention could be interpreted as a warning sign, suggesting that the institutional environment and aging might initiate a process of functional destructuring, even in individuals with preserved cognition (Kozak-Szkopek et al., 2025; Lezak et al., 2012; Lopes et al., 2021; Palese et al., 2016; Strauss et al., 2006; World Health Organization, 2015).

### *The "Floor Effect" and the Limits of Psychometrics in Geriatrics*

The observation of an absolute "floor effect" in the cognitive impairment group, constitutes a methodological finding that appears to evidence a possible inadequacy of classic psychometric instruments to monitor clinical evolution in advanced stages of frailty (Lezak et al., 2012). The fact that 100% of participants reached the minimum score suggests that the Beery VMI may lose its discriminative sensitivity below a certain threshold, which could be masking clinically meaningful micro-adaptations (Zapata-Gil et al., 2026). Therefore, future clinical trials in this population should prioritize assessment measures based on Activities of Daily Living (ADL) performance over abstract psychometric tests (Lopes et al., 2021; Palese et al., 2016).

### *Specificity, Dosage, and Chronobiology of Adaptation*

The absence of statistically significant gains in motor coordination and VMI could corroborate the hypothesis of neuromuscular specificity. Although multicomponent exercise is recognized as effective for global domains, the data appears to indicate that there might not be an automatic transfer of these adaptations to fine motor skills in this population (Izquierdo et al., 2021; Lam et al., 2018; Venegas-Sanabria et al., 2022). It is suggested that the "minimum effective dose" for fine motor skills in frail older adults might be higher than that which was applied, pointing to the potential need for protocols with a higher frequency of fine manipulation tasks (Castellote-Caballero et al., 2024; Gheysen et al., 2018; Li et al., 2021; Rao et al., 2021).

### *Study Limitations*

The reduction in sample size between assessment moments reflects the clinical instability inherent to the "oldest-old" population. Although this loss may reduce statistical power, the final sample appears to maintain high ecological validity by representing the actual context of residential facilities.

A critical limitation identified is the inadequacy of the Beery VMI test's metric sensitivity for the cognitive impairment group in the post-intervention assessment. Additionally, the absence of a passive control group limits the ability to attribute absolute causality. However, the decline observed in the NCI group suggests that institutional pressures may exert an effect of greater magnitude than that provided by the protocol. It is possible that the eight-week duration was insufficient to induce measurable changes, although it may have helped maintain performance against expected decline.

## Conclusions

The preliminary findings of this study suggest that the implementation of the multicomponent exercise program evidenced that the intervention's efficacy and the validity of its monitoring may be strongly conditioned by the baseline cognitive profile. Statistical analysis indicates that visuomotor integration capacity appears to act not only as an outcome variable but potentially as a determinant predictor of motor coordination, possibly playing a central role in the mechanics of manual dexterity.

Regarding Visuomotor Integration, critical duality was observed. On one hand, the data point to a potential metric inadequacy of conventional instruments to assess older adults with severe cognitive impairment given the existence of a "floor effect" that may make monitoring clinical fluctuations challenging. On the other hand, regression analysis suggests that this integrative competence could be a relevant driver of motor execution, indicating that the rehabilitation of handwriting and manipulation might depend significantly on the efficiency of communication pathways between visual and motor systems.

Concerning Motor Coordination, the absence of significant gains, even with a protocol that included weekly fine motor tasks ("task-specific training"), allowed for a preliminary refinement of the understanding regarding exercise prescription in this age group (mean age of 86 years). These results may indicate that the mere inclusion of specific exercises at a weekly frequency might be insufficient to induce measurable adaptations. The improvement of these skills in the oldest-old seems to potentially require a substantially higher dosage, suggesting that the neural plasticity necessary for fine dexterity might depended on high-frequency stimulation. Additionally, the functional deterioration observed in cognitively preserved older adults could underscore the continuous impact of the institutional environment.

In summary, this study suggests that improving global physical fitness or the occasional introduction of specific tasks may not automatically translate into gains in manual dexterity. The data point towards a possible need for a paradigm shift in clinical practice: to preserve manual autonomy in frail older adults, it might be necessary to increase the volume and frequency of specific tasks. Simultaneously, the identification of limitations in classic psychometric instruments reinforces the consideration of assessment metrics that are more ecological and sensitive to low levels of functionality.

However, these conclusions should be interpreted with caution due to the study's limitations, including the lack of a randomized control group and the relatively short intervention period. Future research should prioritize randomized controlled trials (RCTs) with larger samples to validate these observations. Additional studies are needed to determine the minimum effective dose for fine motor interventions in institutionalized populations.

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