
Instrumental Activities of Daily Living in Neurocognitive Disorders: Determinants and Clinical Implications for Health Promotion

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Article

Instrumental Activities of Daily Living in Neurocognitive Disorders: Determinants and Clinical Implications for Health Promotion

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Abstract: Background/Objectives: Instrumental Activities of Daily Living (IADL) are key indicators of autonomy and functional ability in older adults with neurocognitive disorders (NCDs). Their performance is influenced by cognitive, motor, and psychosocial factors. However, specific predictors of IADL performance across the NCD spectrum is less well-characterized. This study aimed to identify cognitive, motor, and caregiver-related determinants of IADL in individuals with minor and major NCDs. **Methods:** A cross-sectional study was conducted in 117 participants referred from a university dementia clinic. Standardized tools for IADL (Lawton IADL Scale), cognition [Addenbrooke's Cognitive Examination III (ACE-III)], Functional Cognitive Assessment Scale (FUCAS)], motor functions, balance, and mobility [Tinetti Test, Timed Up and Go (TUG)], emotional status [Geriatric Depression Scale (GDS)], neuropsychiatric symptoms [Neuropsychiatric Inventory (NPI)], and caregiver burden [Zarit Burden Interview (ZBI)] were administered. Multiple regression analyses were performed to identify predictors of IADL score. **Results:** In the total sample (n=117), IADL performance was significantly predicted by ACE-III, FUCAS, and Tinetti-balance, explaining 75.1% of IADL variance. In minor NCD group (n=41), IADL performance was predicted by FUCAS, Tinetti-balance, and ZBI (adjusted R²=0.697). In major NCD group (n=76), ACE-III, FUCAS, Tinetti-balance, and disease duration were significant predictors (adjusted R²=0.673). For all models, worse profile on the previous variables predicted impaired IADL. **Conclusions:** Global cognitive decline, executive dysfunction in everyday problem-solving situations, balance impairment, and caregivers' burden are critical determinants of IADL in NCDs. Comprehensive assessments and multidisciplinary interventions, including caregiver support, are essential for health promotion by preserving autonomy and functional independence in older adults.

Keywords: Instrumental Activities of Daily Living; neurocognitive disorders; cognition; problem-solving; balance; caregivers' burden; health promotion

1. Introduction

The ageing population is a global phenomenon, which helps explain the rapid increase in the incidence of Alzheimer's disease (AD)—the most common cause of NCDs [1]. Greece, in particular, is among the most rapidly ageing countries in Europe [2], and according to projections by the Organisation for Economic Co-operation and Development (OECD), it is expected to become the most elderly nation on the continent by 2050. In Greece, current estimates suggest that approximately 200,000 individuals are living with NCDs [2]. Considering that each patient significantly impacts the lives of 2–3 family caregivers, it is evident that nearly 1.5 million Greek citizens are directly affected by this condition. The annual economic burden of NCDs in Greece is estimated to be around €3 billion [3].

Functionality in everyday activities is a key criterion for diagnosing NCDs [4]. For this reason, assessing functional ability in daily life is crucial, as it can both support the diagnostic process and indicate the level of disability. Moreover, maintaining functionality is a central component of “healthy ageing,” while “usual ageing” typically involves a decline in functional capacity and, consequently, in quality of life [5–7]. According to the World Health Organization's International Classification of Functioning, Disability and Health (ICF) model, disability and functionality result from interactions between personal and environmental factors, and these can be evaluated through specific activities [8]. In addition, the assessment of disability must be contextualized within each sociocultural setting [9,10].

The importance of the sociocultural context in understanding functional disability has been previously highlighted [11], with reports of significant regional variations in disability levels—lowest in Northern and Western Europe. Disability, by definition, often entails a loss of autonomy and increased dependence on others for care [12]. This pattern is commonly observed in the progression of NCDs, from minor to major NCDs [13]. Furthermore, such dependence occurs not only in Alzheimer's disease but also in other neuropathologies [14]. Emerging evidence highlights that IADL performance is influenced by a combination of cognitive, motor, and psychosocial factors [15–17]. Moreover, caregivers' burden, especially in the early stages of NCDs, may indirectly affect patients' autonomy and has been identified as a key psychosocial factor in the progression of functional decline [12,15,19].

Taking all the above into consideration, it becomes evident that functional ability in IADL is a multidimensional construct influenced by cognitive, motor, and psychosocial factors. However, limited research has explored the specific determinants of functional decline in individuals with NCD spectrum, especially in Greece. Therefore, the present study aims to investigate the key cognitive, motor, emotional, neuropsychiatric, and caregiver-related variables that affect IADL performance, with the goal of identifying early indicators of functional deterioration and informing targeted interventions for health promotion by preserving autonomy and quality of life in older adults with NCDs.

2. Materials and Methods

A cross-sectional study was designed to assess the determinants of IADL in individuals with NCDs. All data were collected in accordance with the Declaration of Helsinki and in compliance with the Ethics Committee of the University Hospital of Alexandroupolis ($\Delta\Sigma 1/\Theta 68/06-04-2020$). Written informed consent was obtained from all participants in the study. Approval was also required for the demented patients by their caregiver and/or by a legal representative. The data were analyzed anonymously.

2.1. Participants

Data regarding 117 participants in an ongoing registry of the Outpatient Dementia Center of the Neurology Department of the University Hospital of Alexandroupolis with minor and major NCDs were included in the study.

2.1.1. Inclusion/ Exclusion Criteria

The interview gathered biographical and medical information, including medical diagnoses, history of cardiovascular, metabolic, and neurological conditions, as well as affective disorders. Individuals with NCDs underwent a comprehensive neurological examination, neuropsychological assessment, and gait evaluation. Caregivers provided additional insights through cognitive and functional assessments of the patient, along with a burden inventory measuring their own caregiving strain.

A total of 41 individuals met the diagnostic criteria for minor NCDs as outlined in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) [18]. These criteria include: (a) a decline in cognitive functioning, either self-reported or observed by a family member or clinician; (b) cognitive impairment relative to the individual's age, confirmed through formal neuropsychological testing; (c) objective evidence of gradual cognitive decline beyond normal aging, without meeting the threshold for dementia; (d) preserved overall cognitive abilities and daily functioning; and (e) the absence of a prior dementia diagnosis or other conditions (e.g., depression, delirium, intoxication, or psychosis) that could account for the impairment.

A total of 76 individuals met the diagnostic criteria for major NCDs. The criteria include: (a) significant cognitive decline from a previous level of performance, as reported by the individual, a family member, or a clinician; (b) objective evidence of substantial cognitive impairment in one or more domains (e.g., memory, executive function, attention, language, visuospatial skills) confirmed through standardized neuropsychological testing; (c) cognitive deficits that interfere with the individual's ability to perform instrumental or basic activities of daily living independently; (d) a progressive deterioration in cognitive function beyond what is expected in normal aging; and (e) exclusion of alternative explanations for the impairment, such as delirium, major psychiatric disorders (e.g., depression or psychosis), substance intoxication, or other medical conditions.

Exclusion criteria included cognitive deficits caused by secondary factors, as confirmed through laboratory tests such as vitamin B12 and folate levels, as well as thyroid function assessments. Additionally, participants with structural brain abnormalities detected on conventional MRI—such as territorial infarction, intracranial hemorrhage, brain tumors, hydrocephalus, or traumatic brain injury—were excluded. Finally, individuals who were unable to walk independently and required assistive devices for mobility were not included in the study.

2.2. Measures

In this study, a series of standardized assessment tools were used to evaluate key cognitive, functional, emotional, neuropsychiatric, and mobility-related factors in individuals with NCDs. These measures were selected to assess IADL, executive function, overall cognitive performance, balance, gait, mobility, and caregiver burden. By incorporating multiple validated tools, the study aims to provide a comprehensive understanding of the interplay between cognition, motor function, and daily living abilities in individuals with NCDs. The following section details each of the assessments used in this study.

IADL: The Lawton IADL Scale [19,20] is a widely used tool for assessing an individual's ability to perform complex daily tasks necessary for independent living. It evaluates eight functional domains: telephone use, shopping, food preparation, housekeeping, laundry, transportation, medication management, and financial management. Scoring ranges from 0 (dependent) to 8 (independent). Although primarily self-reported, the IADL scale provides valuable insights into a person's capacity to live independently and can guide interventions to maintain or improve their functional status.

Cognition: The Addenbrooke's Cognitive Examination III (ACE-III) [21,22] is a comprehensive cognitive screening tool designed to assess various cognitive functions, including memory, language, attention, and visuospatial skills. It is widely used by healthcare professionals, particularly neurologists and geriatricians, to detect and monitor cognitive impairments associated with conditions such as Alzheimer's disease. The ACE-III evaluates five cognitive domains: attention and orientation, memory, verbal fluency, language, and visuospatial abilities. It comprises a series of tasks and questions, with a maximum possible score of 100, where higher scores indicate better cognitive functioning and lower scores may suggest cognitive impairment.

The Functional Cognitive Assessment Scale (FUCAS) [23] is a cognitive-behavioral tool designed to evaluate executive function in everyday problem-solving situations among individuals with dementia and mild cognitive impairment (MCI). Unlike many existing assessments that rely on self-reports or caregiver observations, FUCAS directly evaluates executive function through structured tasks. This scale assesses seven key executive function parameters across six daily activities, including telephone communication, shopping, orientation in place, medication management, personal hygiene, and dressing. The executive function parameters measured include problem awareness, working memory, planning, time distribution, step sequencing, accuracy, and goal maintenance. FUCAS provides subscores for each executive function parameter and a total score ranging from 42 to 126, with higher scores indicating greater cognitive impairment.

Motor functions, balance and mobility: The Tinetti Test, also known as the Performance-Oriented Mobility Assessment (POMA) [24], is a widely used clinical tool for assessing balance and gait in older adults and predicting fall risk. It consists of two subscales: the balance assessment, which evaluates static and dynamic balance through tasks such as sitting, rising from a chair, standing, turning, and reacting to external perturbations, and the gait assessment, which examines step length, step symmetry, step continuity, trunk stability, and gait initiation. Each subscale is scored separately, with the balance component typically rated on a 16-point scale and the gait component on a 12-point scale, resulting in a total possible score of 28 points. Higher scores indicate better mobility and balance, whereas lower scores suggest a greater risk of falls. While different studies propose varying cut-off values, scores below 19–21 points are generally associated with an increased risk of falling.

The Timed Up and Go (TUG) Test [25] is a widely used clinical assessment designed to evaluate mobility, balance, and fall risk in older adults. It measures the time required for an individual to stand up from a chair, walk a distance of three meters (10 feet), turn around, walk back, and sit down again. The test is performed at a normal walking pace. A completion time of ≤ 10 seconds is considered normal, while ≥ 12 –14 seconds indicates an increased risk of falls. Observations of gait stability, stride length, and balance control during the test can provide additional insights into neuromuscular impairments.

Emotional status and neuropsychiatric symptoms: Emotional status was evaluated by the Geriatric Depression Scale (GDS) for the detection of depressive symptoms [26,27]. Patient's neuropsychiatric disturbances were assessed through the Neuropsychiatric Inventory (NPI) administered to caregivers [28].

Caregivers' burden: The Zarit Burden Interview (ZBI) [29] is one of the most widely used tools for assessing caregiver burden, particularly in those caring for individuals with dementia. It evaluates the emotional, financial, and physical strain experienced by caregivers through 22 self-reported items, each rated on a 5-point Likert scale. The total score ranges from 0 to 88, with higher scores indicating greater caregiver burden. Typically, a score of 61 or above signifies a high level of burden, while lower scores suggest mild to moderate burden.

2.3. Statistical Analysis

Continuous variables are presented as mean \pm standard deviation (SD) whereas categorical variables are presented as absolute values. Normality was evaluated before further analysis. Regression analysis was applied to identify the contribution of patients' demographics, disease duration, cognitive and neuropsychiatric profile, and motor functions, as well as caregivers' burden on patients' IADL total score. Therefore, IADL total score was used as dependent variable whereas the following variables were entered as predictors: age, sex, education, disease duration, ACE-III total score, FUCAS, GDS, NPI total score, TUGG, TINETTI-gait, and TINETTI-balance, and caregivers' ZBI. The analysis was conducted for the total group and then separately for the groups of minorNCD and majorNCD. Multicollinearity was assessed by examining the correlation matrix and multicollinearity diagnostics (i.e., tolerance, variance inflation factor). The level of statistical significance was set at $p < 0.05$. All analyses were conducted using the IBM SPSS v. 29.

3. Results

3.1. Group Characteristics

We included 117 patients with minorNCD (n = 41) and majorNCD (n = 76). Patients' demographic, clinical, cognitive, neuropsychiatric, and motor characteristics are presented in Table 1. The two groups differed on age, education, ACE-III total score, FUCAS, NPI total score, TUG and IADL total score, as well as caregivers' ZBI. Patients with MajorNCD were older and less educated compared to patients with MinorNCD whereas they also showed a worse profile on the above mentioned cognitive, neuropsychiatric, and motor variables.

Table 1. Group characteristics for the total group of 117 patients as well as the two groups of MinorNCD and MajorNCD.

	Total group	MinorNCD	MajorNCD	p-value
Age (years)	74.87±8.42	72.07±9.08	76.38±7.69	0.008
Sex (M / F)	50 / 67	17 / 24	33 / 43	0.838
Education (years)	10.34±4.72	11.76±4.86	9.58±4.50	0.017
Disease duration (years)	3.52±2.44	3.15±2.81	3.72±2.21	0.224
ACE-III total score	56.59±25.51	78.20±15.25	44.93±22.13	<0.001
FUCAS	67.04±29.80	46.44±13.18	78.16±30.39	<0.001
GDS	3.32±2.61	3.54±2.61	3.20±2.61	0.504
NPI total score	11.58±13.76	7.02±9.54	14.04±15.06	0.008
TUG (sec)	9.25±3.39	7.83±3.02	10.02±3.36	<0.001
TINETTI-gait	10.47±2.82	11.07±2.35	10.15±3.01	0.070
TINETTI-balance	13.99±3.38	14.81±3.12	13.55±3.45	0.054
IADL total score	18.15±9.31	11.27±5.81	21.87±8.73	<0.001
Caregivers' ZBI	22.34±18.10	13.66±14.12	27.03±18.35	<0.001

Notes. M / F = Male / Female; ACE-III = Addenbrooke's Cognitive Examination 3rd edition; FUCAS = Functional Cognitive Assessment Scale; GDS = Geriatric Depression Scale; NPI = Neuropsychiatric Inventory; TUG = Timed Up and Go Test; IADL = Instrumental Activities of Daily Living; ZBI = Zung Burden Inventory. Differences on continuous variables between MinorNCD and MajorNCD were examined using t-test for independent samples whereas differences on sex distribution were tested using Chi square.

3.2. Determinants of IADL

Patients' ACE-III total score, FUCAS, and TINETTI-balance significantly predicted the IADL total score ($F_{3,116} = 117.386$; $p < 0.001$), accounting for 75.1% of the variance (Table 2). Regression B coefficients refer to the expected mean difference in IADL total score when each predictor increases by one unit. Negative effects were found for ACE-III total score ($B = -0.120$; $p < 0.001$) and TINETTI-balance ($B = -0.716$; $p < 0.001$). Therefore, the worse the TINETTI-balance and ACE-III total score, the higher the IADL total score. On the other hand, positive effects were found in the case of FUCAS ($B = 0.149$; $p < 0.001$) i.e. the higher the FUCAS score, the higher the IADL total score corresponding to worse ADL.

When MinorNCD patients were considered separately, we found that FUCAS, TINETTI-balance and caregivers' ZBI significantly explained 69.7% of the variance of IADL total score ($F_{3,40} = 31.662$; $p < 0.001$). Higher FUCAS ($B = 0.219$; $p < 0.001$), lower TINETTI-balance ($B = -0.835$; $p < 0.001$) and higher caregivers' ZBI ($B = 0.103$; $p = 0.032$) were associated with higher IADL total score.

When MajorNCD patients were considered separately, we found that ACE-III, FUCAS, TINETTI-balance, and patients' disease duration significantly explained 67.3% of the variance of IADL total score ($F_{4,75} = 39.544$; $p < 0.001$). Lower ACE-III total score ($B = -0.092$; $p = 0.018$), higher FUCAS ($B = 0.137$; $p < 0.001$), lower TINETTI-balance ($B = -0.613$; $p = 0.001$), and longer disease duration ($B = 0.655$; $p = 0.021$) were associated with higher IADL total score.

Table 2. Summary of regression analysis with IADL as dependent variable for the total group and separately for the MinorNCD and the MajorNCD groups.

	Unstandardized B	Standard error B	Standardized beta	p-value
Total group	Model: $F_{3,116} = 117.386$; $p < 0.001$; adjusted $R^2 = 0.751$			
ACE-III total score	-0.120	0.028	-0.328	< 0.001

FUCAS	0.149	0.025	0.478	< 0.001
TINETTI-balance	-0.716	0.136	-0.260	< 0.001
<i>MinorNCD</i>		Model: $F_{3,40} = 31.662$; $p < 0.001$; adjusted $R^2 = 0.697$		
FUCAS	0.219	0.049	0.496	< 0.001
TINETTI-balance	-0.835	0.163	-0.449	< 0.001
Caregivers' ZBI	0.103	0.046	0.251	0.032
<i>MajorNCD</i>		Model: $F_{4,75} = 39.544$; $p < 0.001$; adjusted $R^2 = 0.673$		
ACE-III total score	-0.092	0.038	-0.233	0.018
FUCAS	0.137	0.029	0.477	< 0.001
TINETTI-balance	-0.613	0.180	-0.242	0.001
Disease duration	0.655	0.278	0.166	0.021

Notes. MinorNCD = minor neurocognitive disorder; MajorNCD = major neurocognitive disorder; FUCAS = Functional Cognitive Assessment Scale; ACE-III = Addenbrooke's Cognitive Examination 3rd edition; ZBI = Zung Burden Inventory. Only significant predictors for the final model are presented.

4. Discussion

The present study examined the factors determining IADL performance in 117 individuals with NCDs. Our findings indicate that 75% of the variance in total IADL scores is explained by three key variables: ACE-III, FUCAS, and TINETTI-balance. Specifically, higher FUCAS scores were associated with increased IADL performance, while higher TINETTI-balance and ACE-III scores were linked to decreased IADL performance. Further subgroup analysis revealed distinct patterns between individuals with MinorNCDs and MajorNCDs. Among the MinorNCD group, 69.7% of the variance in IADL was explained by FUCAS, TINETTI-b, and the ZBI. In contrast, for the MajorNCD group, 67.3% of the variance in IADL was explained by ACE-III, FUCAS, TINETTI-b, and disease duration. Our findings support previous research efforts which emphasized the necessity of identifying factors associated with IADL decline, particularly in aging populations, to inform effective healthcare strategies [30] and add to the existing literature by providing additional evidence of the determinants of IADL across the spectrum of NCDs from minor to major NCDs.

4.1. IADL and Cognition in NCDs

The findings of this study suggest that general cognitive status plays a crucial role in IADL performance, especially in MajorNCDs. IADL require more complex neuropsychological processing capacity than basic activities of daily living (BADL), making them more susceptible to deterioration due to cognitive decline [31]. Individuals with mild AD exhibit substantial impairments in IADL, 45–65% of them are unable to perform routine tasks at baseline whereas up to 85% require assistance after three years [31]. Some studies do not find a strong correlation between all cognitive measures and IADL performance. For example, Martyr et al. [32] reported that attention, rather than executive functions or memory, is a significant predictor of BADL in dementia patients. These findings suggest that other cognitive domains may play a crucial role in functional abilities [33]. Additionally, differences in study methodologies, sample characteristics, and assessment tools may contribute to the variability in findings across studies.

The present study found that as disease duration increases in individuals with MajorNCD group, their ability to perform IADL worsens. Numerous studies support the association between prolonged disease duration and worsening IADL performance. Individuals exhibited a gradual decline in IADL over the ten years preceding a clinical diagnosis of dementia, suggesting that functional impairments emerge progressively as the disease advances [34]. However, contrasting evidence suggests that functional decline in IADL does not always follow a linear trajectory. Some studies indicate that self-perceived IADL impairments may precede measurable cognitive decline and predict future declines in cognitive functions such as memory, reasoning, and processing speed [35]. Additionally, individual differences in lifestyle, caregiver support, and compensatory mechanisms can influence the rate of IADL deterioration. For instance, individuals with strong social

support networks and structured daily routines may exhibit slower functional decline despite prolonged disease duration.

4.2. IADL and Executive Function Under Everyday Problem-Solving Situations in NCDs

The relationship between cognitive functions and functional abilities has been extensively studied, with growing evidence suggesting that executive function and problem solving plays a critical role in performing IADL. These activities, which include tasks such as managing finances, grocery shopping, and medication adherence, require complex cognitive processes such as planning, decision-making, and problem-solving. Research indicates that impairments in executive function significantly impact an individual's ability to perform these tasks, leading to a decline in functional independence [36–40]. Executive dysfunction has been found to be particularly associated with limitations in IADL. Previous studies have underscored the critical role of executive abilities in managing daily tasks by reporting that greater impairment in executive functions correlates with lower performance in IADL [41]. Similarly, impairments in both executive functions and memory have been strongly linked to difficulties in performing IADL [40]. Furthermore, individuals with more pronounced executive dysfunctions exhibited greater limitations in both basic (BADL) and IADL [42], with IADL being more strongly affected. On the other hand, individuals with MCI and dementia who exhibited executive dysfunction had significantly reduced IADL abilities. Moreover, individuals with MCI tended to complete IADL tasks more slowly and with lower accuracy compared to healthy controls, often demonstrating intermediate performance levels between cognitively healthy individuals and those with mild AD [39]. Functional deficits in IADL have been observed early in the course of cognitive impairment, even before the onset of dementia [43]. This led Winblad et al. [13] to revise the diagnostic criteria for MCI to acknowledge that mild impairments in IADL can occur before dementia is fully developed.

4.3. IADL and Balance in NCDs

In the present study, balance impairments significantly impact the ability to perform IADL in the spectrum of NCDs, i.e. complex tasks essential for independent living [44]. Balance and mobility impairments have been linked to reduced functional independence, highlighting the importance of physical function in maintaining daily living activities [30]. Cognitive decline may be associated with impairments in bodily systems responsible for balance, supporting the idea that balance could serve as an early indicator of cognitive deterioration in older adults [45]. Additionally, the deterioration of cognitive abilities affects gait control and postural adjustments, further exacerbating IADL impairments [44,46]. Furthermore, several studies have identified a clear correlation between executive function and balance in older populations—independent of the type of balance assessment tool employed [47–50] and particularly in dynamic balance and mobility-related tasks [50]. In MinorNCDs, research indicates that physical functions, including balance [45,51], significantly influence IADL performance. IADL functioning in individuals with MCI is associated with both cognitive functions, such as memory and executive function and physical functions, including balance and mobility [16]. This suggests that as balance performance improves individuals may experience better IADL functioning. Moreover, Tinetti balance scores are predictive not only of mobility-related outcomes but also of cognitive performance, reinforcing the link between motor function and higher-order cognitive abilities [52]. Individuals with Parkinson's disease-related MCI (PD-MCI) show significantly more physical disabilities in IADL, poorer Tinetti balance scores, and greater gait impairments than those with Alzheimer's disease-related MCI (AD-MCI) [53]. Studies have collectively underscored the role of balance impairments in limiting IADL performance; this association may vary across different underlying pathologies and may be stronger among individuals with more severe NCDs [54]. Considering that deficits in IADL often emerge early in cognitive decline and are a strong predictor of disease progression [31] and that physical activity plays a preventive role in reducing IADL impairments [30,55,56], interventions targeting mobility and postural stability may help mitigating functional decline [57,58].

4.4. IADL and Caregivers' Burden in NCDs

Our study revealed a significant finding: as scores on the IADL decrease, indicating greater functional impairment, scores on the ZBI, which measures caregiver burden, increase. This correlation was observed exclusively among caregivers of individuals with MinorNCDs. Several studies support the link between functional impairment and increased caregiver burden [59–62]. Caregivers of individuals with neurobehavioral symptoms report significantly higher levels of distress, particularly as dependency on daily activities increases [63]. Functional impairment has been identified as one of the strongest predictors of caregiver burden, surpassing even the direct impact of cognitive decline. This is supported by findings that the greater the patient's dependence on assistance for daily living activities, the higher the emotional, physical, and financial strain experienced by caregivers [64,65]. Of note, caregiver burden is not only influenced by the patient's actual level of impairment but also by the caregiver's perception of the patient's abilities [66].

Interestingly, our study found that this association was significant only for caregivers of individuals with MinorNCDs, rather than those caring for individuals with more advanced NCDs. This finding aligns with research indicating that caregiver burden in the early stages of cognitive impairment can be particularly high due to the uncertainty surrounding disease progression and the ambiguity of care needs [63,66–69]. Caregivers of individuals with mild impairment often struggle with "presenteeism," where they continue their caregiving roles despite physical and emotional exhaustion, leading to long-term health deterioration [70]. Additionally, early stages of cognitive decline involve difficulties in complex IADL, which often go unrecognized until caregivers begin to experience strain [71]. Research suggests that caregiver burden is influenced not only by patient impairment but also by external factors such as social support, access to resources, and caregiver psychological resilience [63,65]. Some caregivers, particularly those with strong support networks, do not report significantly higher burden levels despite the progression of cognitive impairment in care recipients. Additionally, subjective caregiver distress has been found to be a more powerful predictor of burden than objective patient impairment, suggesting that psychological coping mechanisms play a crucial role in moderating the caregiving experience [72].

4.5. Strengths and Limitations

This study has some notable strengths. First, it utilizes a comprehensive set of standardized assessment tools to evaluate cognitive, functional, emotional, neuropsychiatric, and mobility-related factors in individuals with NCDs. The inclusion of multiple validated scales allows for a multi-dimensional analysis of the interplay between cognition, emotional and neuropsychiatric profile, physical function, and caregivers' burden. Additionally, the study is conducted in a real-world clinical setting, enhancing the ecological validity of the findings. Despite these strengths, the study also has certain limitations. Its cross-sectional design prevents the determination of causal relationships between cognitive, functional, and mobility-related factors. Longitudinal studies would be needed to assess changes over time and establish predictive relationships. Another limitation is the sample size, which, while sufficient for statistical analyses, may not be large enough to generalize findings to broader populations. Additionally, selection bias may be present, as participants were recruited from a single neurological outpatient clinic, potentially limiting the generalizability of the results to other settings. Finally, although objective assessments were used, some measures, such as the Lawton IADL Scale and ZBI, rely on self-reports or caregiver input, which could introduce subjective bias.

4.6. Future Directions and Clinical Implications

Future studies should employ longitudinal designs to track changes in functional abilities over time and establish causal relationships between cognitive decline, mobility impairments, and IADL performance. Additionally, larger and more diverse samples from multiple clinical settings will enhance the generalizability of the findings. Integrating biomarkers, neuroimaging, and advanced gait analysis techniques could also provide a more comprehensive understanding of the underlying mechanisms contributing to functional decline.

From a clinical perspective, these findings underscore the need for a multidisciplinary approach for the assessment and management of patients with NCDs. The strong association between IADL

performance and patients' general cognitive status, executive functions under everyday problem-solving situations, and balance, suggests that early interventions targeting both cognitive and motor function may help maintain independence and delay functional decline. Routine screening using standardized tools can assist clinicians in identifying individuals at risk of functional deterioration. Furthermore, the study highlights the critical role of caregivers' burden, emphasizing the need for support programs, psychoeducation, and respite care services to alleviate stress and improve caregiver well-being. Incorporating personalized rehabilitation strategies, including cognitive training, physical therapy, and balance exercises, could improve functional outcomes and reduce the risk of falls. Additionally, assistive technologies, home modifications, and structured daily routines may enhance independent living for individuals with NCDs, therefore assisting to health promotion in aging population. Moving forward, a patient-centered, integrative approach that combines cognitive, physical, and psychosocial interventions will be essential in optimizing care and improving quality of life for both patients and their caregivers.

5. Conclusions

This study underscores the importance of early detection and prevention in managing NCDs, highlighting the strong link between cognition, balance, caregivers' burden and daily living abilities. The identification of general cognitive dysfunction and executive dysfunction in everyday problem-solving situations, as well as balance impairments at an early stage through standardized tools can facilitate timely interventions to slow functional decline and maintain independence. A preventive, multidisciplinary approach, combining cognitive training, physical rehabilitation, and caregiver support, is essential for reducing disability risk and enhancing quality of life. Addressing caregiver burden through structured support services is also crucial in sustaining long-term care. Future research should focus on developing proactive strategies to improve early screening and intervention, ultimately promoting better patient and caregiver outcomes.

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