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Association Between Pain Distribution and Limitations in Basic and Instrumental Activities of Daily Living: A Cross-Sectional Study Based on the Survey of Health, Aging and Retirement in Europe on the Influence of Biopsychosocial Variables and Lifestyle

Diana Salas-Gómez [1], Ángel Denche-Zamorano [2,*], Cristina Mendoza-Holgado [1,*] and Sabina Barrios-Fernandez [1]

[1] Social Impact and Innovation in Health (InHEALTH), Nursing and Occupational Therapy College, University of Extremadura, 10003 Caceres, Spain
[2] Promoting a Healthy Society Research Group (PHeSO), Faculty of Sport Sciences, University of Extremadura, 10003 Caceres, Spain
* Correspondence: denchezamorano@unex.es (Á.D.-Z.); cristinamh@unex.es (C.M.-H.)

Featured Application

Widespread pain in older adults is associated with increased limitations in both Basic and Instrumental Activities of Daily Living compared to localized pain in its absence. Targeted interventions addressing physical activity and biopsychosocial risk factors could reduce limitations in the Basic and Instrumental Activities of Daily Living.

Abstract

Pain is a common condition among older adults and a key factor influencing daily functioning. This cross-sectional study examined how pain presence and distribution (no pain, localized pain [LP], and widespread pain [WP]) are related to limitations in Basic and Instrumental Activities of Daily Living (BADLs and IADLs). Data were drawn from the Survey of Health, Aging, and Retirement in Europe (SHARE) Wave 9, including 68,839 participants aged 50 or older. A clear gradient of functional limitation was observed: Individuals with WP reported the highest number of limitations, followed by those with LP, while those with no pain showed minimal impairment. These associations remained significant after adjusting for age, sex, cognitive status, physical health, and psychosocial factors, with adjusted prevalence ratios (aPRs) for WP of 1.77 for BADLs and 1.22 for IADLs ($p < 0.001$). Notably, depression, perceived loneliness, long-term illness, physical inactivity, and mobility limitations were especially relevant among participants with WP. The findings suggest the clinical value of assessing and implementing interventions not only in the presence but also in the extent of pain to better identify individuals at greater risk of losing independence in daily life.

Keywords: elderly; health-related behaviors; independence; pain; physical activity

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1. Introduction

The global population is aging rapidly. By 2030, one in six people will be over 60, and by 2050, the number of older adults will double to 2.1 billion, with the 80+ age group tripling to 426 million [1]. This rapid growth in the elderly population is placing significant pressure on the healthcare system [2,3]. Among the characteristics of older people is multimorbidity, which affects more than 60% of this population and is closely related to functional decline, increased use of health services, and mortality risk [4]. In Europe, up to 21.5% of older adults report limitations in Basic Activities of Daily Living (ADL) and almost 47% in Instrumental Activities of Daily Living (IADL), especially among those over 75 years of age [5]. This situation requires a response to ensure the sustainability of systems, and for this reason, initiatives such as the United Nations Decade of Healthy Aging (2021–2030) have been launched to improve the functionality of older people by promoting environments and health systems that support autonomy, prevent disability, and support healthy aging in all aspects [6]. Moreover, international guidelines emphasize that physical activity is essential for healthy aging, as it helps preserve independence, reduces disability, and offers therapeutic value in frailty, cognitive decline, and chronic diseases [7,8].

According to the Occupational Therapy Practice Framework (OTPF-4), BADLs include essential self-care tasks such as bathing, dressing, and eating, while IADLs involve more complex tasks needed for independent living, such as cooking, managing finances, or using transportation [9]. Chronic pain, especially when it is multisite or musculoskeletal, is significantly associated with greater functional limitations in older adults, affecting both BADLs and IADLs [10].

The International Association for the Study of Pain describes pain, in its updated definition in 2020, as an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage [11]. Pain assessment and intervention must consider aspects such as intensity, duration (acute versus chronic), distribution (localized versus generalized), and frequency, which are also predictive of frailty and functional decline in older adults [12,13].

Various biopsychosocial variables and lifestyle factors are associated with pain in older people. Older adults with pain in multiple parts of the body experience significant limitations in both lower limb mobility (e.g., walking, climbing stairs, etc.) and upper limb function (e.g., reaching for objects, lifting objects, etc.), which together can contribute to increased disability and risk of falls [14]. Older adults with chronic musculoskeletal pain often show poorer physical performance (reduced strength, balance, and endurance), which can intensify both pain and disability [15]. In this regard, it is important to highlight that handgrip strength (HGS) is a reliable indicator of health and functionality in older people [16–18]. While low levels have been linked to an increased risk of limitations in ADLs, hospitalizations, and mortality, its protective role in maintaining autonomy and preventing functional decline has been demonstrated in various studies. Chronic pain and depression often coexist, showing a bidirectional and reinforced relationship: Pain increases the risk of new depressive symptoms appearing, while depression can aggravate pain intensity and functional impairment [19]. Pain may increase the risk of perceived loneliness in older adults [20]. Then, emotional vulnerability may increase the risk of pain onset and intensify depressive symptoms when pain occurs [21]. Optimism can buffer the daily impact of pain by fostering goal-directed behavior, which in turn reduces pain interference and reinforces a positive feedback loop of well-being in older people [22,23]. Moreover, chronic pain is associated with poorer cognitive performance in community-dwelling older adults [24].

Considering all the above, the main objectives of this study were the following:

- To analyze the associations between reporting more than one limitation in ADLs, both basic and instrumental, the presence of pain, and the extent of its distribution (LP vs. WP), in a population of retired, middle-aged, and older European adults. Additionally, to compare the proportions of individuals with more than one limitation in BADLs and IADLs according to pain presence and its distribution.

- To assess the number of limitations in BADLs and IADLs among retired, middle-aged, and older European adults based on the presence or absence of pain and its distribution (LP vs. WP).
- To identify, among sociodemographic, lifestyle, and biopsychosocial variables, the factors associated with the number of limitations through a Poisson regression model.

The following hypotheses were established before this study:

- In middle-aged and older retired Europeans, pain and its spread (LP vs. WP) are associated with the presence of more than one limitation in BADLs and IADLs.
- People with pain have a greater number of limitations in BADLs and IADLs than people without pain, with those with WP having the greatest number of limitations.
- Mobility limitations, long-term illnesses, and physical inactivity are the main factors associated with a greater number of limitations in ADLs and IADLs. Conversely, greater relative HGS is the main factor associated with fewer limitations.

2. Materials and Methods

2.1. Study Design, Data Collection, and Procedures

This cross-sectional study used data from the Survey of Health, Aging, and Retirement in Europe (SHARE) Wave 9, a multidisciplinary study conducted biennially to investigate the aging process in the adult population across European countries.

The sampling for Wave 9 followed a probabilistic approach, consistent with the methodology used in Wave 8. Households were selected where at least one adult spoke the official language of the country and resided within the national territory during data collection. In addition to participants from previous waves and existing national refreshment samples, Wave 9 also included new national replacement samples that could not be incorporated earlier due to the suspension of fieldwork during the COVID-19 pandemic in the spring of 2020. In contrast to many other studies, the SHARE includes individuals residing in nursing homes and other residential care facilities, as long as they are within the scope of the SHARE coverage. Fieldwork for Wave 9 took place between October 2021 and September 2022. All participants provided informed consent before participation. The interviews covered a wide range of domains, including sociodemographic background, physical and mental health, and cognitive functioning. The SHARE project was approved by the Ethics Committee of the University of Mannheim for Waves 1 to 4, and subsequently by the Ethics Council of the Max Planck Society for all following waves.

Data were accessed upon request through the SHARE Research Data Center. Following approval, the dataset was downloaded in SPSS-compatible format, and the analytical sample was constructed based on the eligibility criteria defined for this study. Further details regarding survey methodology, eligibility, and data handling procedures are available through the SHARE-ERIC website and documentation [25]. Survey of Health, Aging, and Retirement in Europe (SHARE). Available at www.share-eric.eu (accessed on 4 March 2025).

2.2. Sample

The initial sample in the SHARE Wave 9 comprised 69,447 participants from multiple European countries and Israel. For the present study, the only eligibility criterion was being aged 50 years or older. Following this criterion, 606 individuals under 50 years were excluded and two individuals who did not report their age, resulting in a final analytical sample of 68,839 European participants.

2.3. Grouping Criteria

A total of 68,839 participants were included in the analysis. They were first classified into two groups based on their response to the question "Are you troubled with pain?", with response options being "Yes" or "No." Of these, 37,147 participants reported no pain, while 31,692 participants reported being troubled by pain.

Among those who reported pain, a second classification was performed based on the extent of pain, using the question of pain location. Response options included back, hip, knee, other joints, mouth/teeth, other parts of the body (but not joints), and all over. Participants who selected any of the specific body regions—excluding "all over"—were categorized as having localized pain (LP). In contrast, those who selected "All over" were classified as having widespread pain (WP) as shown in Figure 1.

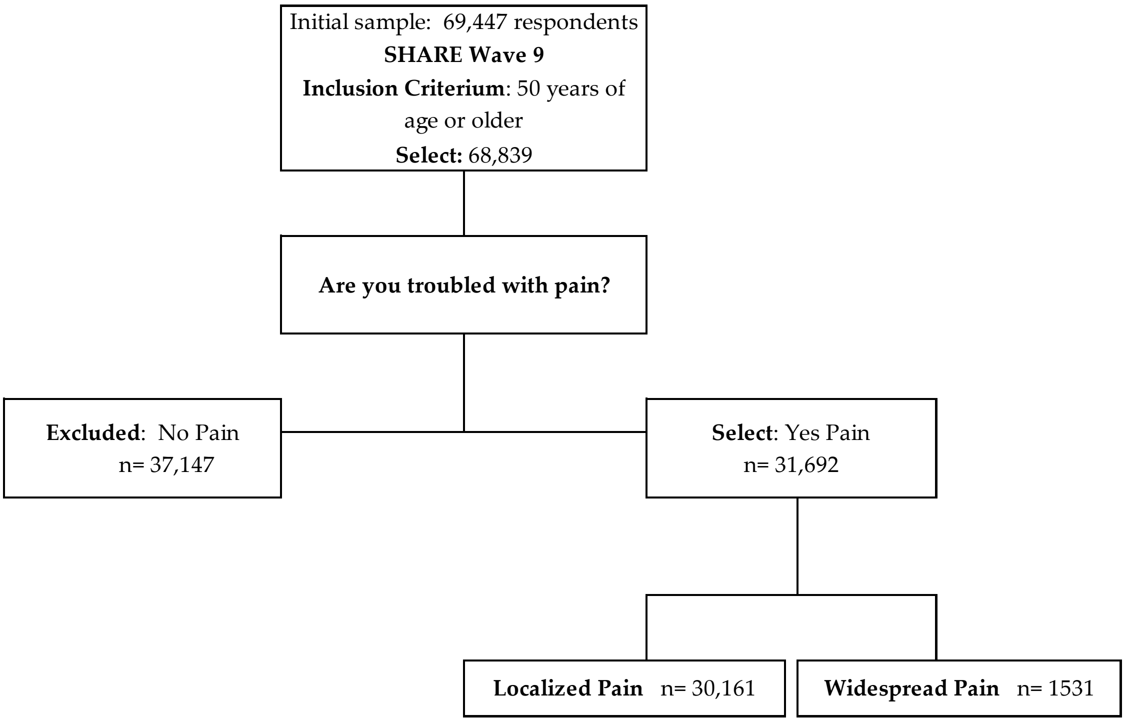

Figure 1. Sample selection flowchart.

2.4. Variables

2.4.1. Characterization Variables

The demographic profile included age (in years), sex (male/female), height (in centimeters), and weight (in kilograms). Educational level was classified according to the International Standard Classification of Education (ISCED-97) [26], distinguishing the following categories: no formal education, preschool education, primary education, lower secondary, upper secondary, post-secondary non-tertiary, first-cycle tertiary education, and currently enrolled in education. Body Mass Index (BMI) was calculated using the standard formula (kg/m^2) and categorized as underweight (<18.5), normal weight ($\geq$18.5 to <25), overweight ($\geq$25 to <30), and obese ($\geq$30). Regarding chronic health conditions, participants were provided with a definition of long-term disease as a health problem of extended duration. They were then asked whether they suffered from any such illness, disease, disability, or condition. The response format was dichotomous: "Yes" or "No".

Physical condition was evaluated through three domains: handgrip strength (HGS), motor difficulties, and physical inactivity. HGS was measured using a Smedley portable dynamometer (TTM, Tokyo, Japan; capacity: 100 kg). Participants were instructed to exert maximum force while grasping the device. Two measurements were taken per hand, and values were considered valid if the intra-hand difference did not exceed 20 kg [27,28]. The highest value recorded across all trials was retained and subsequently normalized by body weight (expressed as kg/weight in kg; HGS ratio). To assess mobility and upper limb/fine motor difficulties, participants were asked whether they experienced limitations in a range of 10 functional tasks, including walking 100 m, remaining seated for two hours, rising from a chair, climbing one or multiple flights of stairs, bending, kneeling, squatting, reaching overhead, pulling or pushing heavy objects, lifting over 5 kg, and picking up a coin from a table. Responses were dichotomous ("Yes" = 1, "No" = 0). Based on this information, a composite variable was created to reflect +3 mobility and upper limb/fine motor limitations, categorizing individuals with more than three reported mobility impairments and additional difficulties in upper extremity or fine motor tasks. Lastly, physical inactivity was determined by self-reported frequency of moderate (e.g., gardening, car washing, walking, etc.) and vigorous (e.g., sports, heavy housework, physically demanding jobs, etc.) activities. Participants who reported never engaging in either were classified as physically inactive.

Mental health was evaluated through two key indicators: depression and perceived loneliness. Depression was assessed using the EURO-D scale [29], developed by a European consortium to evaluate depressive symptomatology in older populations. This instrument comprises 12 dichotomous items that capture a range of emotional and cognitive symptoms, including sadness, pessimism, suicidal ideation, guilt, sleep disturbance, anhedonia, irritability, appetite changes, fatigue, concentration difficulties, lack of enjoyment, and tearfulness. The total score ranges from 0 to 12, with higher scores indicating more severe depressive symptoms. The EURO-D scale has demonstrated good convergent validity with other established mental health measures and robust reliability across multiple studies [30–32]. For analysis purposes, scores were dichotomized: values from 0 to 3 were classified as an absence of depression, while scores $\geq$4 indicated the presence of depressive symptoms [33]. Perceived loneliness was measured using the Three-Item Loneliness Scale [34], which assesses perceived social isolation. Participants rated how frequently they felt unaccompanied, left out, or isolated from others, using a 3-point Likert scale (1 = almost never, 2 = sometimes, 3 = often). The total score ranged from 3 to 9, with higher scores reflecting greater perceived loneliness. This brief scale has shown adequate internal consistency in previous research (Cronbach's $\alpha > 0.80$) [35].

Cognitive functioning was assessed through a composite score ranging from 0 to 29 points, based on performance in orientation, memory, and executive function tasks. Orientation was evaluated by asking participants to correctly report the current day of the week, date, month, and year (1 point each). Memory was measured using immediate and delayed recall of a 10-word list, assigning 1 point for each correctly remembered item in both tasks. Executive function was assessed through a serial subtraction task, in which participants performed five consecutive subtractions, receiving 1 point per correct response. The final score was computed as the sum of all correct responses across the three domains, with higher scores indicating better cognitive functioning.

Dispositional optimism was assessed through two self-report items referring to participants' expectations about daily life and future opportunities. Participants were asked (1) "How often do you look forward to each day?" and (2) "How often do you think life is full of opportunities?" Responses were recorded on a 4-point Likert scale ("Often", "Sometimes", "Rarely", and "Never"), with higher values reflecting greater levels of optimism.

2.4.2. Dependent Variables

Activities of Daily Living (ADLs), including BADLs and IADLs, were assessed using modified versions of the classical Katz Index of Independence in Activities of Daily Living (Katz ADL) [36] and the Lawton and Brody Instrumental Activities of Daily Living Scale (Lawton IADL) [37], adapted for the SHARE project. BADLs included six items: dressing (including putting on socks and shoes), walking across a room, bathing or showering, eating (e.g., cutting up food), getting up or lying down, and toileting (including sitting down and standing up). Each item was scored dichotomously ("Yes" = 1, "No" = 0), indicating the presence of difficulty. The total BADL score ranged from 0 to 6, with higher scores indicating greater functional limitation. Additionally, a dichotomous variable was created to distinguish participants with more than one reported difficulty (score ≥ 2) from those with none or only one (score ≤ 1). IADLs were evaluated through ten items: preparing a hot meal, shopping for groceries, making a phone call, taking medication, using a map to orient in unfamiliar places, doing house or garden work, managing money (e.g., paying bills and keeping accounts), using public transportation, and doing laundry. Each activity was also scored dichotomously ("Yes" = 1, "No" = 0), yielding a total score from 0 to 10. A binary variable was similarly created to classify participants with more than one difficulty in IADLs versus those with none or only one. For this study, given that both instruments are longstanding scales, some terminological modifications were introduced to align them with the Occupational Therapy Practice Framework—4th edition (OTPF-4), created by the American Association of Occupational Therapy (AOTA) [9]. This update enabled a more contextualized and occupation-centered classification of daily functioning (Table 1).

Table 1. Updated terminology of the modified Katz and Lawton–Brody Scales for the SHARE project, based on the Occupational Therapy Practice Framework (4th Edition).

Terminology Used in the SHARE Project	Correspondence with the Terminological Update Based on the OTPF-4
Basic Activities of Daily Living	
Dressing, including putting on socks and shoes	Dressing
Walking across a room	Home mobility (functional mobility)
Bathing or showering	Bathing, showering
Eating (e.g., cutting up food)	Eating
Getting up or lying down	Transferring (functional mobility)
Toileting (including sitting down and standing up)	Toileting and toilet hygiene
Instrumental Activities of Daily Living	
Preparing a hot meal	Meal preparation
Shopping for groceries	Shopping
Making a phone call	Communication management
Taking medication	Medication management *
Using a map to orient oneself in unfamiliar places	Driving and community mobility
Doing house or garden work	Housekeeping (home establishment and management)
Managing money (e.g., paying bills and keeping accounts)	Financial management
Using public transportation	Using public transportation
Doing laundry	Doing laundry (home establishment and management)

OTPF-4: Occupational Therapy Practice Framework—4th edition. * This activity was previously considered an IADL, but in the OTPF-4, it is now part of the Health Management Occupations.

2.5. Statistical Analysis

The normality of continuous variables across pain groups was tested using the Kolmogorov–Smirnov test. Descriptive analyses included medians (Mdns) and interquartile ranges (IQRs) for continuous variables and absolute and relative frequencies for categorical ones. Means and standard deviations (SDs) were also reported to complement the interpretation of continuous measures. Thus, in order to examine the relationship between pain groups (no pain, LP, WP) and ADL dependence (more than one limitation in BADLs or IADLs), Chi-square tests (χ^2) were applied. When significant, pairwise comparisons of independent proportions were carried out with Bonferroni adjustment, and Cramér's V was used to quantify the strength of the association between variables. Kruskal–Wallis tests (H) were used to assess differences in the number of limitations across pain groups (no pain, LP, WP). Kruskal–Wallis tests (H) were used to assess differences in the number of limitations across pain groups. If the results were significant, Mann–Whitney U tests (U) with Bonferroni correction were performed for pairwise comparisons. Rank biserial correlation coefficients (rrb) were calculated to quantify effect size. Finally, to explore factors associated with the number of BADL and IADL limitations, Poisson regression models were fitted. Predictors included pain distribution, physical inactivity, HGS ratio, mobility, and upper limb/fine motor limitations, sociodemographic variables (age, sex, BMI, and education), mental health (depression and perceived loneliness), cognitive functioning, and dispositional optimism. Model selection was based on the values of the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). Assumptions of independence, residual normality, and absence of influential observations were also verified. Results were reported as adjusted prevalence ratios (aPR) with 95% confidence intervals. Analyses were conducted using IBM SPSS Statistics v.27 (IBM Corp, Armonk, NY, USA), with statistical significance set at $p < 0.05$.

2.6. GenAI Declaration

Generative AI applications (ChatGPT (https://chatgpt.com/) and DeepL (https://www.deepl.com) were used to refine the language and to facilitate the accurate expression of scientific content throughout the manuscript.

3. Results

3.1. Descriptive Analysis

Age, perceived loneliness, HGS ratio, and cognitive functioning did not meet the assumption of normality ($p < 0.001$).

Significant associations were found between pain and age, perceived loneliness, HGS ratio, and cognitive functioning ($p < 0.001$). The median age was 68 years in participants without pain and 71 and 72 years in those with LP and WP, respectively. Participants without pain reported slightly lower loneliness scores (mdn = 3) than those with LP or WP (mdn = 4). Additionally, the HGS ratio was higher in participants without pain and those with LP (mdn = 0.4) compared to those with WP (mdn = 0.3). Participants with WP showed lower cognitive functioning scores (mdn = 16) than those with LP (mdn = 17) and those without pain (mdn = 18) (Table 2). In addition, significant associations were found between pain and all other variables ($p < 0.001$), including sex, BMI, depression, long-term illness, +3 mobility and upper limb/fine motor limitations, education level, physical activity, and dispositional optimism. Although women were overrepresented in all pain categories, their proportion was notably higher in those with LP (63% vs. 37%) and WP (70% vs. 30%). Obesity was more prevalent among individuals with LP (29%) and WP (26%) compared to those without pain (20%). Participants with WP also presented higher rates of depression (62% vs. 39% vs. 17%), long-term illness (86% vs. 73% vs. 39%), +3 mobility and upper limb/fine motor limitations (67% vs. 45% vs. 12%), and physical inactivity (36% vs. 18% vs. 9%) than those with LP or no pain, respectively (Table 2).

Table 2. Sample descriptive analysis.

	No Pain		Localized Pain		Widespread Pain		
	n (37,147)		n (30,161)		n (1531)		
	Median	**(IQR)**	**Median**	**(IQR)**	**Median**	**(IQR)**	***p*-Value**
Age	68	(14)	71	(15)	72	(16)	<0.001 ***
Loneliness	3	(1)	4	(2)	4	(3)	<0.001 ***
Hand Grip Ratio (kg/Weight)	0.4	(0.2)	0.4	(0.2)	0.3	(0.2)	<0.001 ***
Cognitive Functioning	18	(6)	17	(6)	16	(8)	<0.001 ***
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	
Sex							
Men	1762	48%	11,243	37%	453	30%	<0.001 ***
Female	19,385	52%	18,918	63%	1078	70%	
Body Mass Index							
Underweight	420	1%	391	1%	44	3%	<0.001 ***
Normal	13,144	37%	8620	30%	464	33%	
Overweight	15,265	42%	11,442	39%	521	38%	
Obese	7141	20%	8642	29%	363	26%	
Depression							
No	29,978	83%	17,646	61%	500	38%	<0.001 ***
Yes	6028	17%	11,355	39%	810	62%	
Long-term illness							
No	22,619	61%	8150	27%	214	14%	<0.001 ***
Yes	14,449	39%	21,994	73%	1313	86%	
+3 Mobility and upper limb/fine motor limitations							
No	32,676	88%	16,482	55%	496	33%	<0.001 ***
Yes	4374	12%	13,656	45%	1027	67%	
Physical Activity							
Inactive	3473	9%	5333	18%	543	36%	<0.001 ***
Active	33,592	91%	24,794	82%	979	64%	
Education level							
None	729	2%	963	3%	98	6%	<0.001 ***
Pre-primary	3491	9%	4398	15%	350	23%	
Primary	5211	14%	5462	18%	298	20%	
Lower secondary	15,232	41%	11,735	39%	525	34%	
Upper secondary	1912	5%	1450	5%	44	3%	
Post-secondary non-tertiary	10,006	27%	5838	19%	198	13%	
First stage of tertiary education	380	1%	193	1%	9	0%	
Still in school	11	0%	15	0%	2	0%	
Dispositional optimism:							
Look forward to each day							
Often	24,798	68%	17,111	58%	648	48%	<0.001 ***
Sometimes	8273	23%	8456	29%	406	30%	
Rarely	2348	7%	2818	10%	186	14%	
Never	890	3%	922	3%	104	8%	
Full of opportunities							
Often	15,938	44%	8298	28%	308	23%	<0.001 ***
Sometimes	13,984	39%	11,845.	41%	487	36%	
Rarely	5193	14%	6974	24%	342	26%	
Never	1144	3%	2147	7%	208	16%	

n: number; IQR: interquartile range; perceived loneliness (scores: 3–9). A higher value indicates a higher loneliness level; *** (*p*-value < 0.001).

3.2. Pain Status and Basic Activities of Daily Living

Significant associations were observed between pain groups and the presence of more than one limitation in BADLs (χ^2 = 3679.3; df = 2; p < 0.001; V = 0.231). A total of 5% of participants without pain had >1 limitation, compared to 18% with LP and 37% with WP (p < 0.001), with significant differences also between the two pain groups. In IADLs (χ^2 = 4511.5; df = 2; p < 0.001; V = 0.256), 10% of pain-free individuals had >1 limitation, versus 28% and 51% among those with LP and WP, respectively (p < 0.001), with pairwise comparisons confirming significant differences. Detailed comparisons are presented in Table S1, and Figure 2 illustrates the distribution of the limitations across the pain groups.

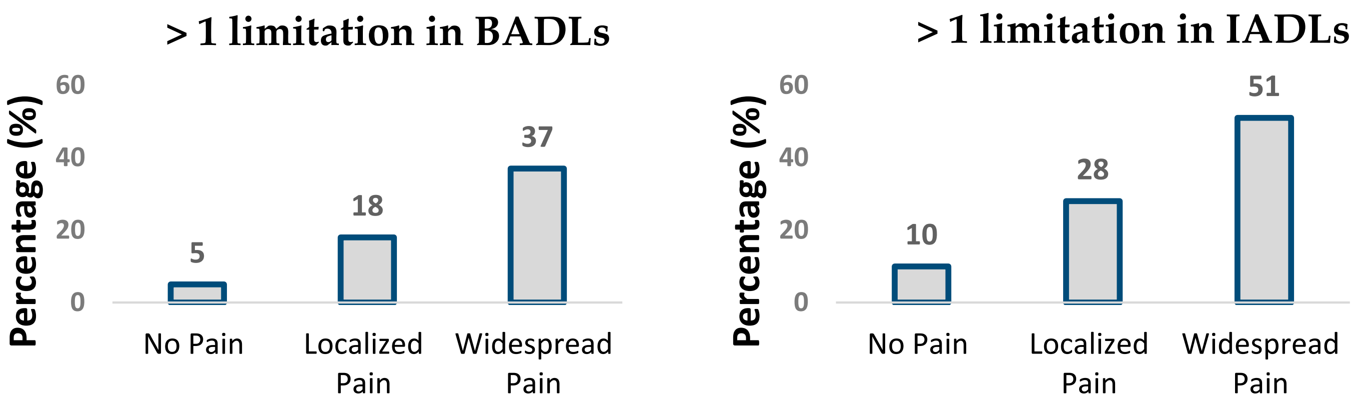

Figure 2. More than one limitation in BADLs and IADLs in people without pain, localized pain, and widespread pain.

Pain was significantly associated with the number of limitations both in BADLs ($p < 0.001$) and in IADLs ($p < 0.001$). Participants with WP exhibited the highest average number of limitations. These results are presented in Table 3.

Table 3. Number of limitations in Basic and Instrumental Activities of Daily Living.

	Mdn	(IQR)	Mdn	(SD)	H	df	*p*-Value	Post Hoc U	*p*-Value
Basic Activities of Daily Living Limitations									
No Pain (1)	0	(0.0)	0.1	(0.6)				1 vs. 2	<0.001 ***
Localized Pain (2)	0	(0.0)	0.4	(1.1)	4569.4	2	<0.001	1 vs. 3	<0.001 ***
Widespread Pain (3)	0	(2.0)	1.2	(1.9)				2 vs. 3	<0.001 ***
Instrumental Activities of Daily Living Limitations									
No Pain (1)	0	(0.0)	0.3	(1.3)				1 vs. 2	<0.001 ***
Localized Pain (2)	0	(1.0)	0.8	(1.8)	3731.4	2	<0.001	1 vs. 3	<0.001 ***
Widespread Pain (3)	1	(4.0)	2.2	(3.0)				2 vs. 3	<0.001 ***

Mdn: median; IQR: interquartile range; H: Kruskal–Wallis test; df: Degrees of freedom; Mann–Whitney's U test for two independent samples, *p*-value: for two-to-two comparisons with Bonferroni correction 0.002; *** ($p < 0.001$).

3.3. Multiple Regression Models

3.3.1. Multivariate Poisson Regression Model of Limitations in Basic Activities of Daily Living

A Poisson regression model was constructed to identify factors associated with the number of limitations in BADLs. The main risk factors for a higher number of BADL limitations were having +3 mobility and upper limb/fine motor difficulties, physical inactivity, and the presence of a long-term illness, along with other variables such as pain, male sex, depression, and low weight. In contrast, a higher HGS ratio was significantly associated with fewer BADL limitations and emerged as the primary protective factor. Specifically, having +3 mobility and upper limb/fine motor limitations was associated with an 8.17 increase in the mean number of BADL limitations. Physical inactivity and long-term illness were also linked to increased risk, 2.21 and 2.03, respectively. Conversely, individuals with the highest HGS ratios experienced a 90% reduction in BADL limitations compared to those with lower ratios (Figure 3 and Table S2).

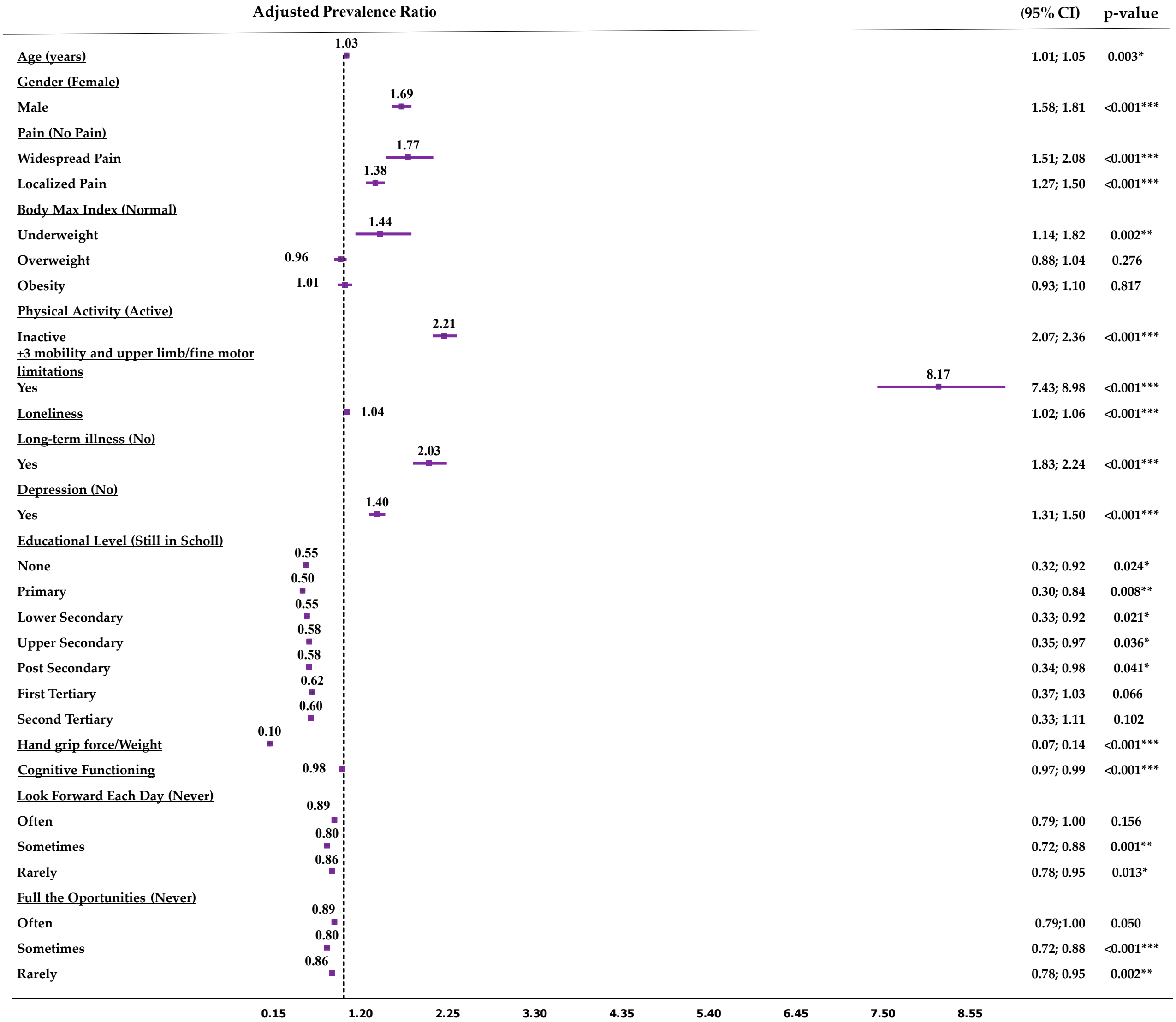

Figure 3. Multivariate Poisson regression including the number of limitations in the Basic Activities of Daily Living as the dependent variable. CI: confidence interval; * p-value < 0.05; ** p-value < 0.01; and *** p-value < 0.001.

3.3.2. Multivariate Poisson Regression Model of Limitations in Instrumental Activities of Daily Living

Regarding limitations in IADL, the main factors associated with a higher number of limitations were +3 mobility and upper limb/fine motor limitations, arm and fine motor difficulties (multiplying the number of limitations by 5.33), physical inactivity (multiplying it by 2.13), and having a long-term illness (multiplying it by 1.89). Once again, a higher HGS ratio was identified with fewer IADL limitations. People with the highest HGS ratio had an 84% reduction in the number of IADL limitations compared to people with a lower HGS ratio (Figure 4 and Table S3).

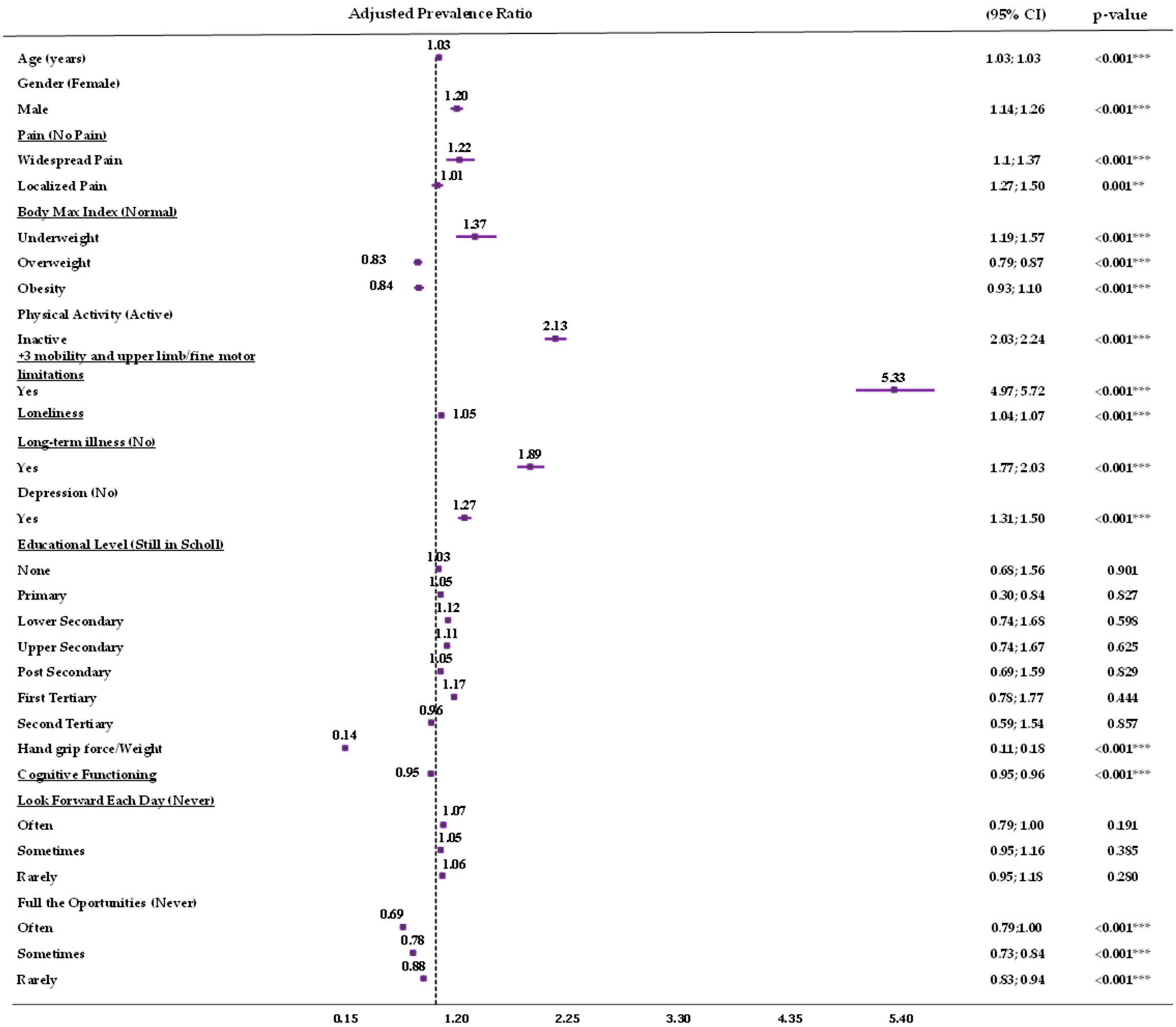

Figure 4. Multivariate Poisson regression including the number of limitations in the Instrumental Activities of Daily Living as the dependent variable. CI: confidence interval; ** p-value < 0.01; and *** p-value < 0.001.

4. Discussion

This cross-sectional study, based on SHARE data, found a clear gradient of functional limitation linked to pain distribution: Individuals with WP showed the highest number of limitations in BADLs and IADLs, followed by those with LP, and lastly, those without pain. These associations remained significant after adjusting for sociodemographic, physical, cognitive, and psychosocial variables. The findings underscore the role of pain, particularly when widespread, as a key determinant of daily functioning in older adults.

The relationship between pain and functional decline in both BADLs and IADLs has been extensively documented in various epidemiological contexts. Studies across diverse populations have consistently shown that chronic pain compromises independent performance in ADLs. For instance, a large-scale study conducted in an Indian older adult population reported that individuals experiencing pain had a significantly higher likelihood of encountering difficulties in both BADLs and IADLs. In addition, condition-specific research has demonstrated the impact of pain on functional status. A study involving patients with systemic lupus erythematosus found that more than half reported limitations in BADLs and IADLs, closely related to the severity of pain [38]. These findings are consistent with those of the present study, reinforcing the evidence that chronic pain functions as a risk factor for global functional impairment. A study conducted in a sample of 230 women with endometriosis also reported that pain intensity was closely associated with limitations in both BADLs and IADLs, with additional influence from fatigue and other biopsychosocial factors [39]. This convergence of findings across distinct clinical conditions and geographic regions highlights the broad impact of pain on functional performance, regardless of its underlying etiology.

These findings further underscore several latent issues identified in our study, such as the influence of sex and the relevance of biopsychosocial factors. Beyond primary functional disability, our results also highlight the strong psychosocial dimension of pain, which contributes to exacerbating limitations in ADLs. Perceived loneliness, identified in our analysis as a particularly relevant factor among individuals with WP, has previously been recognized in the scientific literature as a key element in the progression of functional decline. A longitudinal study conducted in the general population demonstrated that persistent pain is associated with an increasing risk of developing loneliness, thus establishing a negative feedback loop that heightens both functional and emotional vulnerability in older adults [40]. Similarly, another study in a British sample found that older adults with widespread musculoskeletal pain were twice as likely to report loneliness and low social support, both of which negatively impacted their daily functional capacity [41].

Our study found a higher proportion of women in both pain groups, particularly in the WP group (70%). This pattern aligns with previous evidence reporting a consistently higher prevalence of chronic pain among women [42,43] and supports the need to consider gender differences when addressing functional outcomes related to pain [44].

With regard to physical factors, the associations between pain and anthropometric parameters proved to be complex and non-linear. Although excess body weight has traditionally been linked to a higher prevalence of musculoskeletal pain, our findings revealed heterogeneous patterns depending on pain type. Recent studies suggest that this heterogeneity may be partially explained by the interplay of biomechanical, inflammatory, and neuroendocrine mechanisms, which modulate pain perception based on both the degree and distribution of excess body weight [45,46]. Lifestyle is also related to pain. A SHARE-based analysis of 27,528 cases from 28 countries found that among lifestyle factors, physical inactivity had the strongest link to severe pain, more than poor sleep, smoking, or diet, highlighting its central role in both pain management and healthy aging [47]. Another study based on objective activity data suggests that short bouts of light-to-moderate physical activity (5 to 20 min) can help reduce pain intensity and its impact on daily life in older adults with chronic pain [48].

Another relevant aspect to consider is the participants' cognitive performance. Our findings showed poorer cognitive functioning among individuals with pain, a phenomenon that has also been previously described in the scientific literature. One study identified that persistent pain in older adults is associated with accelerated memory decline and increased risk of dementia [49]. Similarly, longitudinal studies have reported a more pronounced cognitive deterioration—particularly in memory, executive function, and orientation—among individuals with persistent pain trajectories [50]. Therefore, the co-occurrence of pain and cognitive impairment may represent a compounding factor contributing to the extent of independence loss in BADLs and IADLs [24]. However, these findings should be interpreted with caution due to the sociodemographic characteristics of the sample. Age has been consistently recognized as the primary non-modifiable risk factor for cognitive decline, both in the general population and in clinical groups. In this context, the age heterogeneity observed in our sample—particularly the overrepresentation of older participants in the

WP group—may have influenced cognitive scores, potentially contributing to lower values in this subgroup.

Our findings were statistically significant regarding perceived loneliness, long-term diseases, and mobility limitations. In summary, they indicate that individuals with WP exhibit a clinically complex functional profile, characterized by higher rates of depression, perceived loneliness, chronic conditions, mobility impairments, and physical inactivity compared to those with LP or no pain. This pattern aligns with the well-established concept of comorbidity, often observed in chronic WP, where physical, psychological, and social factors interact and mutually reinforce overall functional disability. The co-occurrence of depressive symptoms and pain may generate a bidirectional and synergistic relationship, in which emotional suffering amplifies pain sensitization processes, while persistent pain contributes to the development and maintenance of depressive symptomatology. This interactive model has been extensively supported in recent literature, highlighting the role of shared neurobiological mechanisms underlying both phenomena [51–53].

The number of ADL limitations in our results revealed a clear and progressive pattern in the association between pain and the extent of limitations in both BADLs and IADLs. Participants without pain exhibited virtually no limitations, while those with LP experienced a significant increase, and individuals with WP displayed the highest median limitations (1 in IADLs, up to 2 in BADLs), with all bivariate comparisons reaching statistical significance ($p < 0.001$). These findings support the interpretation of a functional severity gradient, understood as a progressive decline in functional capacity associated with the magnitude and distribution of pain. This stepwise pattern is consistent with prior findings in large epidemiological studies showing a positive association between pain intensity or frequency and functional difficulty in older adults [38,39,54]. Moreover, the pronounced functional limitations associated with WP likely reflect not only its greater clinical burden but also its interaction with comorbid conditions—depression, chronic illnesses, mobility constraints, and physical inactivity—which collectively drive the progressive loss of independence in ADLs.

Among the practical applications is to highlight the relevance of considering the type and distribution of pain when designing strategies to support daily functioning in older adults. Moreover, identifying individuals with WP may be especially important, as they tend to present with greater ADL limitations. Encouraging physical activity, addressing psychosocial factors such as perceived loneliness or depression, and managing chronic conditions within a comprehensive care framework are all essential to preserving functional independence, particularly in BADLs and IADLs. These results are particularly relevant for occupational therapists, physiotherapists, psychologists, physical education professionals, physicians, and other professionals involved in geriatric care. These findings also align with the goals of the 2030 Agenda for Sustainable Development, particularly Objective 3, which promotes healthy lives and well-being at all ages, by supporting strategies aimed at maintaining functional capacity in aging populations [55].

This study has several limitations. First, its cross-sectional design prevents the establishment of causal relationships between pain distribution and limitations in BADLs and IADLs. Although the associations observed are robust, longitudinal analyses would be needed to better understand the temporal dynamics and potential bidirectionality between pain and functional decline. Second, the use of self-reported measures may introduce reporting bias, particularly in the definition and categorization of pain (LP vs. WP), and psychosocial variables such as perceived loneliness or depression. Third, although we adjusted for multiple sociodemographic, clinical, and psychosocial covariates, residual confounding cannot be fully ruled out. Finally, the classification of pain distribution was based on subjective perception rather than clinical or anatomical criteria, which may limit the generalizability of findings across specific pain syndromes or diagnoses. Future research should focus on prospective designs to examine the longitudinal interplay between pain and functional trajectories. In particular, studies exploring the mediating or moderating roles of psychosocial factors and gender-specific patterns may help guide tailored interventions. Moreover, integrating objective functional performance tests and biomarkers of inflammation or sensitization could strengthen the understanding of the mechanisms linking pain and functional disability in aging populations.

5. Conclusions

This study highlights that pain distribution is significantly associated with functional limitations in both BADLs and IADLs among older adults. A clear gradient was observed, with the number of limitations increasing progressively from individuals without pain to those with LP and being highest among those with WP. These associations remained robust after adjusting for multiple physical, cognitive, and psychosocial variables, highlighting the multidimensional impact of pain on functional independence. Notably, individuals with WP had a 77% higher prevalence of BADL limitations and a 22% higher prevalence of IADL limitations compared to those without pain (aPR = 1.77 and 1.22, respectively; $p < 0.001$). These results emphasize the need for targeted, multidimensional approaches to pain assessment and management in older adults, aiming not only to reduce suffering but also to preserve daily life independence. Public health strategies should prioritize systematic surveillance of pain in aging populations and promote policies that support functional independence in older adults living with pain.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/app15148026/s1, Table S1: More than 1 + limitations in people without pain, localized pain, and widespread pain; Table S2: Multivariate generalized Poisson regression including number of Limitations in Basic Activities of Daily Living as the dependent variable; Table S3: Multivariate generalized Poisson regression including number of Limitations in Instrumental Activities of Daily Living as the dependent variable.

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Abbreviations

The following abbreviations are used in this manuscript:

SHARE	The Survey of Health, Aging, and Retirement in Europe
OTFP-4	Occupational Therapy Practice Framework (version 4)
ADLs	Activities of Daily Living
BADLs	Basic Activities of Daily Living
IADLs	Instrumental Activities of Daily Living
LP	Localized Pain
WP	Widespread Pain
HGS	Handgrip Strength

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