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Working Paper Series 97-2025
DOI: 10.6103/wp.972025

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Funded by the European Union
Sponsored by the Federal Ministry of Education and Research
Funded by DFG Deutsche Forschungsgemeinschaft German Research Foundation
Supported by the NIH National Institute on Aging

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Acknowledgements

The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646) and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924) and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, VS 2020/0313, SHARE-EUCOV: GA N°101052589 and EUCOVII: GA N°101102412. Additional funding from the German Federal Ministry of Education and Research (01UW1301, 01UW1801, 01UW2202), the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, BSR12-04, R01_AG052527-02, R01_AG056329-02, R01_AG063944, HHSN271201300071C, RAG052527A) and from various national funding sources is gratefully acknowledged (see **www.share-eric.eu**).

Accelerometer-Measured Physical Activity and ADL/IADL Impairment: A Two-Year Follow-up Analysis

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Abstract:

This study examined the relationship between accelerometer-measured physical activity and the onset of limitations in Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) over two years. ADL and IADL limitations are key indicators of declining independence, and physical activity is known to mitigate such declines. Using data from the eighth and ninth waves of the Survey of Health, Ageing, and Retirement in Europe (SHARE), this study focused on older adults in 10 European countries. The analysis included 617 participants without ADL and 574 individuals without IADL limitations at baseline. Average marginal effects (AME) for the probability of onset of ADL and IADL limitations were reported based on multivariate logistic regressions. Results indicated that higher daily step counts and increased time spent in intense activity are significantly associated with a reduced likelihood of ADL limitations. An increase of 1,000 steps per day was associated with a 1.1 (AME = -0.011; p = 0.004) and 0.9 (AME = -0.009; p = 0.035) percentage point decrease in the probability of ADL and IADL impairment, respectively. One hour more of intense activities per day was correlated with a 6.1 percentage point decrease in the likelihood for an onset of ADL limitations (AME = -0.061; p = 0.029), while the time spent in intense activities per day was not significantly correlated with the onset of IADL limitations (AME = -0.059; p = 0.062). Correlations were stronger for ADL than for IADL and for steps than intense activities. The study highlights the potential of regular physical activity to preserve functional independence in older adults, contributing to public health strategies to reduce the need for long-term care.

Keywords: functional independence, mobility decline, IADL, steps, SHARE

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1 Introduction

Limitations in Activities of Daily Living (ADL) serve as indicators of disability, quality of life decline, and increased mortality rates, particularly among older adults (Guralnik & Ferrucci, 2003; Kekäläinen et al., 2023; Millán-Calenti et al., 2010; Qiao et al., 2021). Maintaining the ability to perform these essential tasks is critical for sustaining independence (Iavarone et al., 2007) and overall well-being, yet many people experience declines in these areas as they age. While substantial research links physical activity with various health benefits and shows cross-sectional correlations between physical activity and ADL performance, a limited number of longitudinal studies examine whether physical activity levels, as objectively measured by accelerometers, can predict the onset of ADL limitations. Clarifying the relationship between physical activity and ADL limitations over time could inform public health strategies and interventions designed to preserve independence and improve the quality of life in aging populations, potentially reducing the need for long-term care.

Activities of Daily Living refer to the essential tasks required for maintaining independence within the community (Kekäläinen et al., 2023). These tasks are divided into basic activities of daily living (ADL) and instrumental activities of daily living (IADL) (Kekäläinen et al., 2023). ADLs encompass basic self-care tasks essential for attending to one's physical well-being, like feeding oneself, getting dressed, and maintaining personal cleanliness. On the other hand, IADLs involve more intricate activities that demand foresight and cognitive effort, such as meal preparation, household chores, shopping, and financial management (Kekäläinen et al., 2023). A decline in the ability to perform basic ADL significantly reduces autonomy (Iavarone et al., 2007) and often leads to the need for informal (Sjölund et al., 2015) or institutional care (Galasko et al., 2004; Gaugler et al., 2007).

Consistent physical activity plays a vital role in promoting well-being as one grows older (Langhammer et al., 2018). Regular physical activity serves as a shield against noncommunicable diseases like cardiovascular disease, stroke, diabetes, and certain cancers (WHO, 2020). Furthermore, engaging in physical activity correlates with enhanced mental well-being (Schuch et al., 2016), a delay in dementia onset (Livingston et al., 2020), and an overall better quality of life (Das & Horton, 2012). Extensive research confirms the positive health outcomes of physical activity, showing that increased levels and more frequent participation are linked to decreased risks and better health across various areas (Langhammer et al., 2018; Musich et al., 2017).

The association of physical activity with limitations in ADL/IADL was investigated in numerous *cross-sectional* studies. Based on *self-reported* physical activity, the correlation of inactivity with a higher probability of ADL/IADL limitations in older adults was demonstrated with data from all around the world, e.g. India (Nontarak et al., 2023), Thailand (Bryant et al., 2020), Korea (Nguyen et al., 2022), Brazil (Garcia Meneguci et al., 2021), Finland (Pullinen et al., 2024), and Ireland (Connolly et al., 2017). Fewer studies were conducted using *device-measured* indicators of physical activity, but they report the same relationship between physical activity and limitations in ADL/IADL. Higher physical activity and lower sedentary behaviour were consistently linked to a better ability to complete Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) (Amaral Gomes et al., 2021).

A cross-sectional correlation between limitations in ADL/IADL and physical activity can result from different mechanisms. On the one hand, limitations in specific activities such as walking and getting up from a chair are likely to be the reason for reduced physical activity. On the other hand, physical activity is an important health behaviour for preventing various diseases and the cross-sectional correlation between limitations in ADL/IADL and physical activity might indicate the protective effect of *previous* physical activity on current performance in ADL/IADL. To better understand the potential causal relationship between physical activity and ADL/IADL limitations, studies with a longitudinal design are needed to provide more robust insights.

Several *longitudinal* studies using *self-reported* physical activity measures are available that underscore the importance of regular physical activity in preventing and slowing ADL and IADL disabilities and maintaining functional independence. Higher physical activity levels and lower sedentary behaviour were linked to better ADL and IADL abilities. Peterson et al. (2009) followed 2,964 participants from the Health, Aging and Body Composition (Health ABC) study for 5 years to investigate the impact of varying levels and types of physical activity on the onset and severity of frailty. Those with sedentary lifestyles showed increased odds of developing frailty. Rector et al. (2020) conducted a longitudinal study over a period of 8 to 20 years using data from the Survey of Midlife Development in the United States. The results indicated that individuals who maintained their physical activity experienced a slower progression of functional limitations compared to those whose activity levels declined more rapidly. Another US study that followed older adults over 8 years showed that the decline in ADLs was reduced in persons who were engaged in vigorous physical activity or exercise three times a week or more (Wolinsky et al., 2011). Analysing longitudinal data from Norway revealed that excessive sitting, irregular sleep, and physical inactivity were important risk factors for ADL/IADL disability (Storeng et al., 2018). A recent study highlights the role of physical activity in protecting against ADL limitations, as the protective effect was also shown in stroke survivors (van Allen et al., 2024).

The systematic review by Amaral Gomes et al. (2021) covering publications until June 2020 identified four *longitudinal* studies using *device-measured* physical activity (Balogun et al., 2020; Cawthon et al., 2013; Dunlop et al., 2019; Shah et al., 2012). All studies demonstrated that greater physical activity and reduced sedentary behaviour were linked to improved performance in ADL and IADL (Amaral Gomes et al., 2021). Cawthon et al. (2013) found that older men with lower energy expenditure, less moderate activity, or more sedentary time were more likely to develop functional limitations. Shah et al. (2012) found that higher total daily physical activity was linked to less disability, even after accounting for self-reported activity. Balogun et al. (2020) used pedometers to study the relationship between physical activity and knee pain and (knee-related) functional limitations in older adults over three points in time in a 5-year interval. Higher physical activity was linked to lower knee pain and functional limitation (Balogun et al., 2020). In a sample of individuals at risk for mobility and ADL limitations due to lower extremity joint symptoms, Dunlop et al. (2019) concluded that a minimum threshold of around 1 hour of moderate-to-vigorous activity per week significantly improved the chances of remaining disability-free (ADL and mobility) over a 4-year period. More recently, Chen et al. (2023) conducted a prospective study on 1,687 Japanese adults aged 65 years and older who were free of functional disability at baseline. Physical activity was measured using a waist-worn accelerometer, and participants were followed for nine years (2011–2020). The study found that higher levels of total sedentary time were associated with an increased risk of incident functional disability.

This paper aims to investigate the relationship between physical activity, as measured by accelerometers, and the onset of limitations in activities of daily living (ADL) and instrumental activities of daily living (IADL) over a two-year follow-up period.

2 Data and Methods

Data from the Survey of Health, Ageing and Retirement in Europe (SHARE) waves 8 and 9 is used for this investigation. SHARE is a panel study of the population aged 50 years and older in many European countries addressing the health, social, and financial situation of the respondents (Börsch-Supan et al., 2013). SHARE Release 9.0.0 Wave 8, conducted in 2019 and 2020, was employed as baseline data, providing information on physical activity, health, and further control variables (SHARE-ERIC, 2024b). SHARE Wave 9, conducted in 2021 and 2022, was used as follow-up yielding information on the onset of limitations in ADLs and IADLs (SHARE-ERIC, 2024c).

Wave 8 of SHARE comprises the SHARE Accelerometer Study, an additional data collection of physical behaviour using acceleration sensors (Bergmann & Börsch-Supan, 2021). A subsample of SHARE respondents in ten countries was asked to wear accelerometers (type “Axivity AX3”) on their upper thigh for eight consecutive days in their everyday life, day and night. The SHARE Accelerometer Study was conducted in Germany, Sweden, Spain, Italy, France, Denmark, Belgium, Czechia, Poland, and Slovenia.

2.1 Measures

2.1.1 Physical Activity

The data of the SHARE Accelerometer Study offers measures on postures and activities obtained from ActiPASS Version 1.61beta (Hettiarachchi & Johansson, 2023). ActiPASS is a software that derives activities and postures, such as standing, sitting, walking, and cycling, based on thigh-worn accelerometer raw data (Skotte et al., 2014). Details on the data processing done by SHARE are available elsewhere (SHARE-ERIC, 2024a). The algorithms used by ActiPASS for step count (Stemland et al., 2015) and activities (Skotte et al., 2014) were validated. Two indicators of physical activity derived from ActiPASS were used in this analysis: the number of steps and the time spent on intense activities. The following activities are considered as intense: fast walking (i.e., cadence ≥100 steps/min), running, cycling, stair climbing, and other periodic movements with a cadence ≥100 steps/min. Both metrics, steps per day and time spent in intense activities (hours), were averaged over all observation days per respondent.

A self-reported measure of physical activity was generated by the response to the question “How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labour?”. A binary variable is generated indicating no vigorous activity (response option “Hardly ever, or never”) and engagement in vigorous activity (response options “More than once a week”, “Once a week”, “One to three times a month”).

2.1.2 Limitations in ADL and IADL

Activities of daily living (ADL) are essential skills required to handle basic physical needs, such as eating, using the toilet, or maintaining personal hygiene (Katz et al., 1963). In SHARE, ADL limitations are identified by six questions assessing difficulties in performing dressing, bathing, eating, using the toilet, getting in and out of bed, and walking across a room (Steel et al., 2003).

Instrumental Activities of Daily Living (IADL), which are generally categorized separately from ADLs, include more complex activities related to independent living in the community, such as managing money, doing laundry, or taking medications (Canada et al., 2021). In the SHARE questionnaire, IADL limitations encompassed difficulties in nine activities, including grocery shopping, preparing hot meals, managing finances, making phone calls, taking medication, using a map, performing housework, doing laundry, leaving the house independently, and accessing transportation services.

For both, limitations in ADL and IADL, a binary variable indicating limitations (one or more vs. none) was used for analyses.

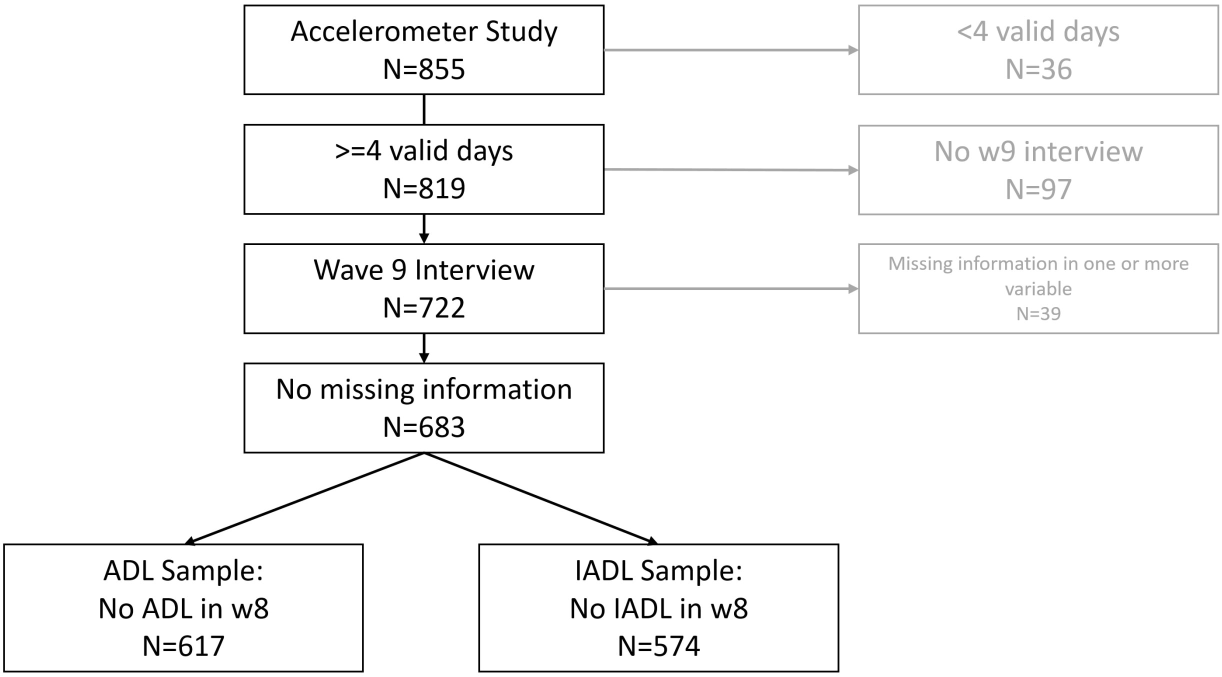
2.1.3 Covariates

Covariates include the respondent's gender and age in years at the time of the interview as well as the country. Education was classified into three levels based on the 1997's International Standard Classification of Education (ISCED), which allows for the standardised reporting of education statistics at the international level (UNESCO, 2006). The seven original ISCED levels were consolidated into a three-level categorical variable: low (no or primary education, ISCED levels 0 and 1), medium (secondary education, ISCED levels 2, 3, and 4), and high (tertiary education, ISCED levels 5 and 6). The financial situation was assessed by asking respondents how easily their household can make ends meet, with responses categorized as with great difficulties, with some difficulties, fairly easily, or easily (Litwin & Sapir, 2009). Health behaviour included smoking and risky alcohol consumption. Smoking was classified into three categories: currently smoking, former smoker, and never smoked. Having consumed six or more units of alcohol on one occasion at least weekly in the last 3 months was considered risky alcohol consumption. Respondents' health was controlled by various indicators. Overweight status was determined by a Body Mass Index (BMI) of 25 or higher. The number of chronic conditions was recorded as 0, 1, or 2 or more, based on self-reported diagnosis of chronic diseases. In addition, variables for suffering from a heart attack or stroke at the time of the interview were generated. Difficulties walking 100 meters were considered in the analysis as a measure of mobility. Difficulties picking up a small coin from a table served as an indicator of fine motor skills. Cognitive functioning was evaluated through memory performance using a 10-word recall test (Brandt et al., 1988; Harris & Dowson, 1982) and an assessment of mathematical performance (numeracy test). In the 10-word recall test, participants listened attentively to a list of 10 words read aloud. They were then asked to recall as many words as they could immediately (immediate recall) and again after a brief interval (delayed recall). The number of correctly recalled words from the immediate recall was used as an indicator of the respondent's memory. Numeracy was evaluated by the "serial seven test" which asks the respondent to perform subtractions. The first question is "One hundred minus 7 equals what?", followed four times by "And 7 from that". An index is generated showing the number of correct answers (0 to 5).

2.2 Sample

From the initial sample of the SHARE Accelerometer Study with the size of N=855, participants were excluded based on several criteria (Figure 1). Participants with less than 4 days of valid accelerometer measurement – defined as 16 hours of valid wear time per day – detected by the ActiPASS software were excluded (N=36). Ninety-seven respondents did not participate in wave 9. Thirty-nine respondents were excluded due to missing data in at least one variable, resulting in a sample of 683 respondents. For the analysis of the onset of ADL/IADL limitations, only those respondents without ADL/IADL limitations in wave 8 were included in the respective analysis sample. Therefore, the samples differ in size and composition (Table 1). The total sample for ADL analysis was 617 participants, with a mean age of 68.2 years and 58% female and 42% male respondents. For IADL analysis, the total sample

Figure 1: Sample inclusion criteria



Data: SHARE Waves 8 & 9, Release 9.0.0

was 574 participants, with a mean age of 67.6 years and 57.8% female and 42.4% male respondents. The valid measurement period of accelerometer data averaged 7.2 days for both ADL and IADL samples, while the time between data collection in wave 8 and wave 9 averaged 25.9 months for both groups (min = 21, max = 33, SD = 2.6).

2.3 Statistical methods

Logistic regression analyses were conducted to examine the relationships between physical activity and the onset of limitations in ADL and IADL. The results are presented as average marginal effects (AME) to facilitate interpretation and provide a more intuitive understanding of the impact of each predictor on the probability of the outcome (Thrane, 2019).

3 Results

Graphs in Figure 2 present the average steps per day, time spent in intense activity, and percentage of self-reported vigorous activity in wave 8 for different groups of ADL and IADL status. Individuals without any ADL or IADL limitations in both waves showed the highest level of activity in all three indicators.

While those without any limitations had approximately 8,000 steps per day, those with limitations in either wave 8 or wave 9 had on average less than 5,300 steps. Individuals who reported ADL or IADL limitations in wave 8[1] were very similar in their physical activity compared to those who reported onset of ADL/IADL limitation in wave 9 (i.e., no ADL/IADL limitation in wave 8, but at least one limitation in wave 9).

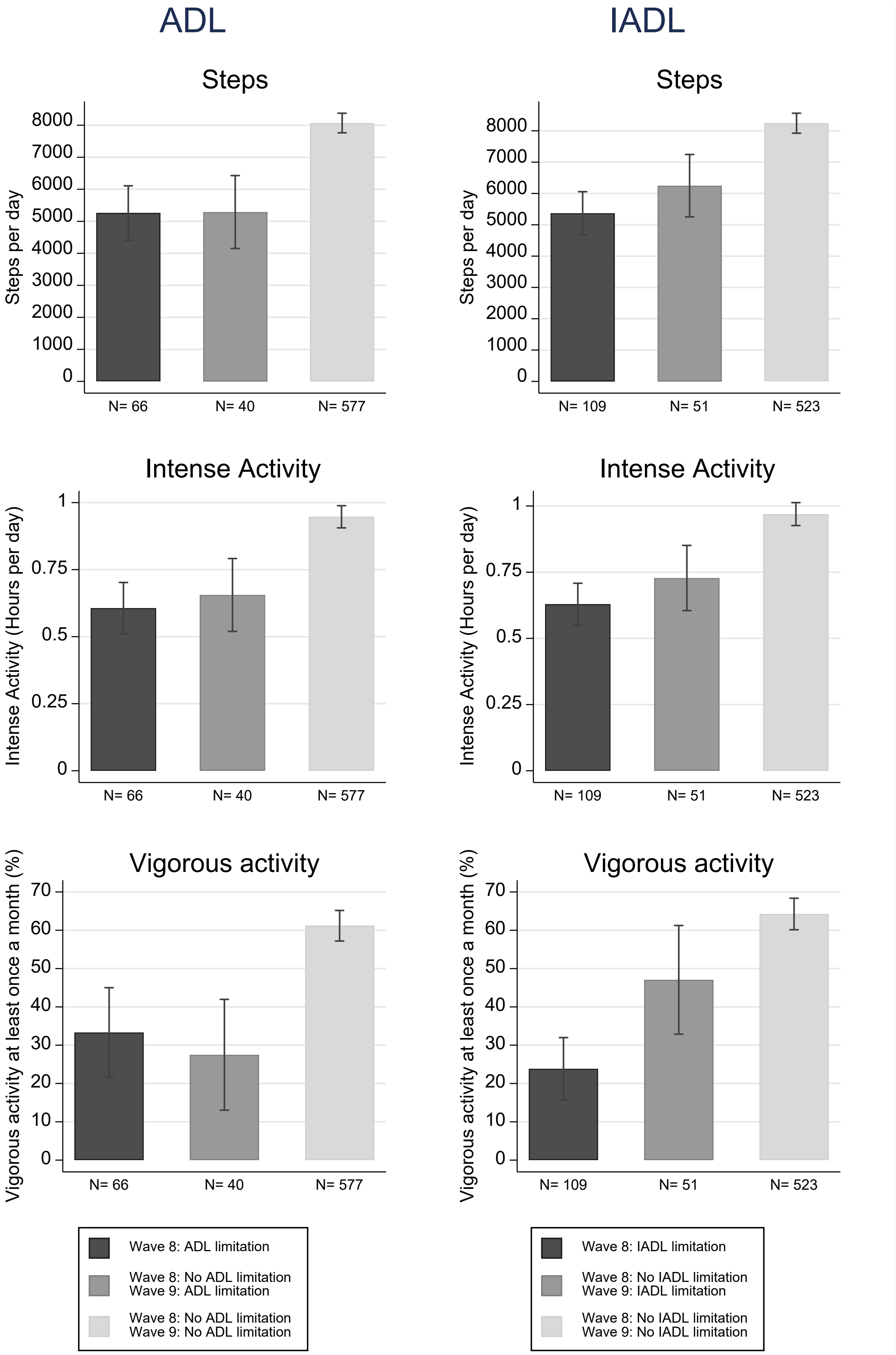
[1] This group is excluded in the regression analyses on onset of ADL/IADL limitations below.

Table 1: Sample description

			ADL Sample N=617	IADL Sample N=574
Steps	In 1,000	mean	7.9	8.1
Intense activity	Hours	mean	0.9	0.9
Self-reported vigorous activity	Hardly ever, or never	%	41.0	37.3
	at least once a month	%	59.0	62.7
Age	Years	mean	68.2	67.6
Gender	Female	%	58.0	57.8
	male	%	42.0	42.2
Smoking	Never	%	54.5	53.5
	Not currently	%	31.0	31.0
	Yes	%	14.6	15.5
Risky alcohol consumption	Yes	%	5.7	5.4
Overweight	Yes	%	66.6	67.2
Chronic disease	No	%	25.8	27.7
	One	%	34.4	34.3
	Two or more	%	39.9	38.0
Education	Low	%	13.6	13.1
	Medium	%	60.9	60.8
	High	%	25.4	26.1
Make Ends Meet	With great difficulties	%	6.8	5.6
	With some difficulties	%	23.5	25.1
	Fairly easily	%	33.9	34.8
	Easily	%	35.8	34.5
Memory test	0-10	mean	5.7	5.7
Numeracy test	0-5	mean	4.3	4.3
Difficulties picking up a small coin	Yes	%	2.1	2.1
Difficulties walking 100m	Yes	%	5.7	3.8
Heart attack	Yes	%	10.4	9.8
Stroke	Yes	%	3.1	2.8
Country	Germany	%	13.6	13.2
	Sweden	%	8.4	8.7
	Spain	%	6.6	6.6
	Italy	%	9.6	9.9
	France	%	9.4	8.9
	Denmark	%	4.5	4.9
	Belgium	%	8.8	8.2
	Czechia	%	12.0	12.0
	Poland	%	13.9	13.9
	Slovenia	%	13.1	13.6
Valid days of accelerometer study	Days	mean	7.2	7.2
Time between w8 & w9	Months	mean	25.9	25.9

Data: SHARE Waves 8 & 9, Release 9.0.0

Figure 2: Mean of steps per day, time spent in intense activity, and self-reported frequency of vigorous activity by ADL and IADL status (with 95% CI).



Data: SHARE Waves 8 & 9, Release 9.0.0 (unweighted).
Note: Numbers available in Appendix 1.

For intense activity, individuals without any limitations in ADL and IADL across both waves averaged 0.95 and 0.97 hours per day of intense physical activity, respectively. In contrast, those who developed ADL and IADL limitations by Wave 9 averaged 0.66 and 0.73 hours, while those with limitations already in Wave 8 averaged 0.61 and 0.63 hours.

Regarding self-reported vigorous physical activity, 61.2% of individuals without ADL limitations in both waves reported engaging in vigorous activity at least once a month. In comparison, only 27.5% of those who developed limitations by Wave 9 and 33.3% of those with limitations in Wave 8 reported similar activity levels. For IADL limitations, the share of individuals with at least monthly vigorous activity in those individuals with an onset of IADL limitation in wave 9 is 47.1 %. This is considerably higher compared to 23.9 % in those individuals with IADL limitations in wave 8.

The logistic regression analysis for the onset of ADL limitations (Table 2 models 1-3) revealed that higher physical activity was associated with a significantly lower probability of developing ADL limitations. The average marginal effect indicated that 1,000 steps more per day were linked to a 1.1 percentage point decrease in the likelihood of ADL limitations (AME = -0.011; 95% CI: -0.003; -0.018). Similarly, each additional hour of intense activity per day and self-report of being vigorously active at least once a month was linked to a lower likelihood of ADL limitations by 6.1 (AME = -0.061; 95% CI: -0.006; -0.116) and 7.5 (AME = -0.075; 95% CI: -0.120; -0.031) percentage points, respectively.

The average marginal effects presented in Table 2 (models 4-6) revealed that an increase in 1,000 steps per day was associated with a decrease in the likelihood of IADL limitations by 0.9 percentage points (AME = -0.009; 95% CI: -0.001 – -0.017). Although pointing in the same direction, the association of time spent in intense activity (AME = -0.059; 95% CI: -0.121; 0.003) and self-reported frequency of vigorous activity (AME = -0.034; 95% CI: -0.086; 0.018) did not show significant correlations to the onset of IADL limitations.

Table 2: Logistic regression for the onset of ADL and IADL limitations: Average marginal effects

	(1)	(2)	(3)	(4)	(5)	(6)
	ADL	ADL	ADL	IADL	IADL	IADL
Steps per day (in 1,000)	-0.011 **			-0.009 *		
	(0.004)			(0.004)		
Intense Activity per day (hours)		-0.061 *			-0.059 +	
		(0.028)			(0.031)	
Vigorously active at least once a month			-0.075 ***			-0.034
			(0.023)			(0.027)
Number of observations	617	617	617	574	574	574
Pseudo R^2	0.211	0.196	0.216	0.171	0.168	0.161

*** p<.001, ** p<.01, * p<.05, + p<.1

Data: SHARE Waves 8 & 9, Release 9.0.0

Note: Standard errors in parentheses. Controls: Age, Gender, Education, make ends meet, Smoking, Alcohol consumption, Overweight, Chronic disease, Stroke, Heart attack, Memory test, Numeracy test, Diff. picking up a coin, Diff. walking 100 m. Full table available in Appendix 2.

4 Discussion

This study showed that sensor-based measures of physical activity were correlated to the onset of limitations in ADL and IADL in a 2-year follow-up in the sample of the SHARE Accelerometer Study in ten European countries. Correlations were stronger for ADL than IADL and for the number of steps than for time spent in intense activity. A stronger impact of physical activity on ADL limitations was expected, as these tasks primarily involve physical abilities. In contrast, a weaker correlation with IADL was observed, as these tasks involve more cognitive abilities, and thus, a broader range of factors influence the ability to perform them. The same pattern of a stronger correlation of physical activity with ADL than IADL was reported in some previous studies (Crevenna & Dorner, 2019; Cwirlej-Sozanska et al., 2019; Martinez-Hernandez et al., 2022; Nguyen et al., 2022). In the present study, similar results were observed for self-reported activity; however, the correlation was not significant for IADL limitations.

The study setup enabled the identification of the onset of ADL and IADL limitations. However, causal interpretation is not possible. As the activity of the ADL/IADL onset group was similar to the group of individuals who reported ADL/IADL limitations at the baseline interview (see Figure 2) and the follow-up period was relatively short, the lower activity level of the onset group – compared to those without any ADL/IADL limitations – might reflect an ongoing decline in physical functioning that was manifested into ADL/IADL limitations in the follow-up period.

Identifying early signs of limitations is crucial for timely intervention, as it allows for strategies to counteract further functional decline. Mobility limitations are commonly observed in older individuals, serving as early signs of potential decline in physical abilities. Indicators such as having trouble walking a quarter mile or ascending one flight of stairs may serve as a warning sign before mobility disability sets in, where walking becomes extremely challenging or requires assistance (Simonsick et al., 2008; Verbrugge & Jette, 1994; Wolinsky et al., 2005). The physical abilities such as mobility, strength in the lower extremities, balance, and walking endurance in older adults who are cognitively sound are highly responsive to training (Binder et al., 2002; Vaitkevicius et al., 2002) and improvement in these areas can directly impact the activities of daily living (Yokoya et al., 2009). Strength training, a form of structured physical activity, has demonstrated effectiveness in both preventing and reversing sarcopenia, i.e. both a reduction in muscle mass and a decline in muscle function (Sánchez-Sánchez et al., 2019). Through training that targets the physical aspects related to ADL healthy older individuals can either stabilise or enhance their ADL performance (Yokoya et al., 2009). Therefore, future initiatives should focus on promoting participation and adherence to exercise programs for older adults, to improve their functional capacities and performance in daily living activities.

A strength of this study is the availability of sensor-based measures of physical activity. This reduces the bias associated with self-reported measures and allows for more precise assessments of the relationship between physical activity and limitations in ADL and IADL. The average number of steps per day provided an appropriate metric that showed a correlation with limitations in ADL and IADL. Also, steps per day are intelligible and relevant for older adults as walking is the most common leisure-time physical activity of older adults (Martin et al., 2014; Vaz de Almeida et al., 1999).

Limitations of the study include the one-time accelerometer measurement of physical activity, not allowing the detection of changes in physical activity levels, and the insufficient number of cases for conducting robust country-specific analyses. Additionally, there may be a selection bias in the accelerometer study, as individuals with mobility limitations or low self-assessed physical activity might have been less likely to participate, potentially leading to an underrepresentation of these groups in the sample (Franzese et al., 2023). However, an assessment of the selection bias in the SHARE Accelerometer Study showed no significant influence of participation selection on another metric (ENMO i.e. average acceleration) (Franzese et al., 2023)

Future studies with not only longer observation periods but more frequent data of both physical activity and ADL/IADL limitations are needed to better describe pathways into ADL and IADL limitations and identify causal – and potentially reciprocal – relations between physical activity and limitations in ADL and IADL. Still, the present study aligns with the plethora of literature reporting correlations of physical activity with various health outcomes, clearly underscoring the importance of early intervention, as addressing declines in physical activity at the onset of ADL limitations may help prevent further deterioration in functional abilities.

5 Acknowledgements

This work was funded by the German Federal Ministry of Education and Research (BMBF) as part of SHARE (grant numbers 01UW1801 / 01UW2202).

The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646) and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924) and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, VS 2020/0313, SHARE-EUCOV: GA N°101052589 and EUCOVII: GA N°101102412. Additional funding from the German Federal Ministry of Education and Research (01UW1301, 01UW1801, 01UW2202), the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, BSR12-04, R01_AG052527-02, R01_AG056329-02, R01_AG063944, HHSN271201300071C, RAG052527A) and from various national funding sources is gratefully acknowledged (see http://www.share-eric.eu).

6 References

Amaral Gomes, E. S., Ramsey, K. A., Rojer, A. G. M., Reijnierse, E. M., & Maier, A. B. (2021). The Association of Objectively Measured Physical Activity and Sedentary Behavior with (Instrumental) Activities of Daily Living in Community-Dwelling Older Adults: A Systematic Review. *Clin Interv Aging*, *16*, 1877-1915. https://doi.org/10.2147/cia.S326686

Balogun, S., Scott, D., Cicuttini, F., Jones, G., & Aitken, D. (2020). Longitudinal study of the relationship between physical activity and knee pain and functional limitation in community-dwelling older adults. *Arch Gerontol Geriatr*, *90*, 104101. https://doi.org/10.1016/j.archger.2020.104101

Bergmann, M., & Börsch-Supan, A. (2021). SHARE Wave 8 Methodology: Collecting cross-national survey data in times of COVID-19. *Munich: MEA, Max Planck Institute for Social Law and Social Policy*.

Binder, E. F., Schechtman, K. B., Ehsani, A. A., Steger-May, K., Brown, M., Sinacore, D. R., Yarasheski, K. E., & Holloszy, J. O. (2002). Effects of exercise training on frailty in community-dwelling older adults: results of a randomized, controlled trial. *Journal of the American geriatrics society*, *50*(12), 1921-1928. https://doi.org/10.1046/j.1532-5415.2002.50601.x

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S., & Zuber, S. (2013). Data Resource Profile: the Survey of Health, Ageing and Retirement in Europe (SHARE). *Int J Epidemiol*, *42*(4), 992-1001. https://doi.org/10.1093/ije/dyt088

Brandt, J., Spencer, M., & Folstein, M. (1988). The telephone interview for cognitive status. *Neuropsychiatry Neuropsychol Behav Neurol*, *1*(2), 111-117.

Bryant, M. S., Kang, G. E., & Protas, E. J. (2020). Relation of chair rising ability to activities of daily living and physical activity in Parkinson's disease. *Archives of Physiotherapy*, *10*, 1-6. https://doi.org/10.1186/s40945-020-00094-8

Canada, B., Stephan, Y., Fundenberger, H., Sutin, A. R., & Terracciano, A. (2021). Cross-sectional and prospective association between personality traits and IADL/ADL limitations. *Psychol Aging*, *36*(3), 309-321. https://doi.org/10.1037/pag0000502

Cawthon, P. M., Blackwell, T. L., Cauley, J. A., Ensrud, K. E., Dam, T. T., Harrison, S. L., Peters, K. W., & Mackey, D. C. (2013). Objective assessment of activity, energy expenditure, and functional limitations in older men: the Osteoporotic Fractures in Men study. *J Gerontol A Biol Sci Med Sci*, *68*(12), 1518-1524. https://doi.org/10.1093/gerona/glt054

Chen, T., Chen, S., Honda, T., Kishimoto, H., Nofuji, Y., & Narazaki, K. (2023). Accelerometer-measured sedentary behavior and risk of functional disability in older Japanese adults: a 9-year prospective cohort study. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1), 91. https://doi.org/10.1186/s12966-023-01490-6

Connolly, D., Garvey, J., & McKee, G. (2017). Factors associated with ADL/IADL disability in community dwelling older adults in the Irish longitudinal study on ageing (TILDA). *Disability and Rehabilitation*, *39*(8), 809-816. https://doi.org/10.3109/09638288.2016.1161848

Crevenna, R., & Dorner, T. E. (2019). Association between fulfilling the recommendations for health-enhancing physical activity with (instrumental) activities of daily living in older Austrians. *Wien Klin Wochenschr*, *131*(11-12), 265-272. https://doi.org/10.1007/s00508-019-1511-8

Cwirlej-Sozanska, A., Wisniowska-Szurlej, A., Wilmowska-Pietruszynska, A., & Sozanski, B. (2019). Determinants of ADL and IADL disability in older adults in southeastern Poland. *BMC Geriatr*, *19*(1), 297. https://doi.org/10.1186/s12877-019-1319-4

Das, P., & Horton, R. (2012). Rethinking our approach to physical activity. *The Lancet*, *380*(9838), 189-190. https://doi.org/10.1016/S0140-6736(12)61024-1

Dunlop, D. D., Song, J., Hootman, J. M., Nevitt, M. C., Semanik, P. A., Lee, J., Sharma, L., Eaton, C. B., Hochberg, M. C., Jackson, R. D., Kwoh, C. K., & Chang, R. W. (2019). One Hour a Week: Moving to Prevent Disability in Adults With Lower Extremity Joint Symptoms. *Am J Prev Med*, *56*(5), 664-672. https://doi.org/10.1016/j.amepre.2018.12.017

Franzese, F., Schrank, F., & Bergmann, M. (2023). Determinants of Consent in the SHARE Accelerometer Study. *Journal for the Measurement of Physical Behaviour*, *6*(4), 271-288. https://doi.org/10.1123/jmpb.2022-0046

Galasko, D., Kershaw, P. R., Schneider, L., Zhu, Y., & Tariot, P. N. (2004). Galantamine maintains ability to perform activities of daily living in patients with Alzheimer's disease. *Journal of the American geriatrics society*, *52*(7), 1070-1076. https://doi.org/10.1111/j.1532-5415.2004.52303.x

Garcia Meneguci, C. A., Meneguci, J., Sasaki, J. E., Tribess, S., & Júnior, J. S. V. (2021). Physical activity, sedentary behavior and functionality in older adults: A cross-sectional path analysis. *Plos one*, *16*(1), e0246275. https://doi.org/10.1371/journal.pone.0246275

Gaugler, J. E., Duval, S., Anderson, K. A., & Kane, R. L. (2007). Predicting nursing home admission in the US: a meta-analysis. *BMC geriatrics*, *7*, 1-14. https://doi.org/10.1186/1471-2318-7-13

Guralnik, J. M., & Ferrucci, L. (2003). Assessing the building blocks of function: utilizing measures of functional limitation. *American journal of preventive medicine*, *25*(3), 112-121. https://doi.org/10.1016/S0749-3797(03)00174-0

Harris, S., & Dowson, J. (1982). Recall of a 10-word list in the assessment of dementia in the elderly. *The British Journal of Psychiatry*, *141*(5), 524-527. https://doi.org/10.1192/bjp.141.5.524

Hettiarachchi, P., & Johansson, P. (2023). *ActiPASS (v1.61-beta)* Zenodo. https://doi.org/10.5281/zenodo.7701098

Iavarone, A., Milan, G., Vargas, G., Lamenza, F., De Falco, C., Gallotta, G., & Postiglione, A. (2007). Role of functional performance in diagnosis of dementia in elderly people with low educational level living in Southern Italy. *Aging Clinical and Experimental Research*, *19*, 104-109. https://doi.org/10.1007/BF03324675

Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A., & Jaffe, M. W. (1963). Studies of illness in the aged: the index of ADL: a standardized measure of biological and psychosocial function. *jama*, *185*(12), 914-919. https://doi.org/10.1001/jama.1963.03060120024016

Kekäläinen, T., Luchetti, M., Sutin, A., & Terracciano, A. (2023). Functional Capacity and Difficulties in Activities of Daily Living From a Cross-National Perspective. *J Aging Health*, *35*(5-6), 356-369. https://doi.org/10.1177/08982643221128929

Langhammer, B., Bergland, A., & Rydwik, E. (2018). The Importance of Physical Activity Exercise among Older People. *Biomed Res Int*, *2018*, 7856823. https://doi.org/10.1155/2018/7856823

Litwin, H., & Sapir, E. V. (2009). Perceived Income Adequacy Among Older Adults in 12 Countries: Findings From the Survey of Health, Ageing, and Retirement in Europe. *The Gerontologist*, *49*(3), 397–406. https://doi.org/10.1093/geront/gnp036

Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne, C., Burns, A., Cohen-Mansfield, J., & Cooper, C. (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *The Lancet*, *396*(10248), 413-446. https://doi.org/10.1016/S0140-6736(20)30367-6

Martin, K. R., Cooper, R., Harris, T. B., Brage, S., Hardy, R., Kuh, D., & NSHD Scientific Data Collection Team. (2014). Patterns of leisure-time physical activity participation in a British birth cohort at early old age. *Plos one*, *9*(6), e98901. https://doi.org/10.1371/journal.pone.0098901

Martinez-Hernandez, B. M., Rosas-Carrasco, O., Lopez-Teros, M., Gonzalez-Rocha, A., Munoz-Aguirre, P., Palazuelos-Gonzalez, R., Ortiz-Rodriguez, A., Luna-Lopez, A., & Denova-Gutierrez, E. (2022). Association between physical activity and physical and functional performance in non-institutionalized Mexican older adults: a cohort study. *BMC Geriatr*, *22*(1), 388. https://doi.org/10.1186/s12877-022-03083-7

Millán-Calenti, J. C., Tubío, J., Pita-Fernández, S., González-Abraldes, I., Lorenzo, T., Fernández-Arruty, T., & Maseda, A. (2010). Prevalence of functional disability in activities of daily living (ADL), instrumental activities of daily living (IADL) and associated factors, as predictors of morbidity and mortality. *Archives of gerontology and geriatrics*, *50*(3), 306-310. https://doi.org/10.1016/j.archger.2009.04.017

Musich, S., Wang, S. S., Hawkins, K., & Greame, C. (2017). The frequency and health benefits of physical activity for older adults. *Population health management*, *20*(3), 199-207. https://doi.org/10.1089/pop.2016.0071

Nguyen, V. C., Moon, S., Oh, E., & Hong, G.-R. S. (2022). Factors associated with functional limitations in daily living among older adults in Korea: a cross-sectional study. *International Journal of Public Health*, *67*, 1605155. https://doi.org/10.3389/ijph.2022.1605155

Nontarak, J., Bundhamcharoen, K., Prasitsiriphon, O., & Aekplakorn, W. (2023). The Association of Sociodemographic Variables and Unhealthy Behaviors With Limitations in Activities of Daily Living Among Thai Older Adults: Cross-sectional Study and Projected Trends Over the Next 20 Years. *Asian/Pacific Island Nursing Journal*, *7*, e42205. https://doi.org/10.2196/42205

Peterson, M. J., Giuliani, C., Morey, M. C., Pieper, C. F., Evenson, K. R., Mercer, V., Cohen, H. J., Visser, M., Brach, J. S., Kritchevsky, S. B., Goodpaster, B. H., Rubin, S., Satterfield, S., Newman, A. B., Simonsick, E. M., for the Health, A., & Group, B. C. S. R. (2009). Physical Activity as a Preventative Factor for Frailty: The Health, Aging, and Body Composition Study. *The Journals of Gerontology: Series A*, *64A*(1), 61-68. https://doi.org/10.1093/gerona/gln001

Pullinen, P., Parkkari, J., Kaprio, J., Vaha-Ypya, H., Sievanen, H., Kujala, U., & Waller, K. (2024). Association Between Accelerometer-Measured Physical Activity and Mobility Limitations in Twins. *J Aging Phys Act*, 1-9. https://doi.org/10.1123/japa.2023-0445

Qiao, Y., Liu, S., Li, G., Lu, Y., Wu, Y., Shen, Y., & Ke, C. (2021). Longitudinal follow-up studies on the bidirectional association between ADL/IADL disability and multimorbidity: results from two national sample cohorts of middle-aged and elderly adults. *Gerontology*, *67*(5), 563-571. https://doi.org/10.1159/000513930

Rector, J. L., Marceau, K., & Friedman, E. M. (2020). Moderation of the association between chronic medical conditions and functional limitations over time by physical activity: effects of age. *The Journals of Gerontology: Series A*, *75*(1), 168-174. https://doi.org/10.1093/gerona/glz020

Sánchez-Sánchez, J. L., Mañas, A., García-García, F. J., Ara, I., Carnicero, J. A., Walter, S., & Rodríguez-Mañas, L. (2019). Sedentary behaviour, physical activity, and sarcopenia among older adults in the TSHA: isotemporal substitution model. *J Cachexia Sarcopenia Muscle*, *10*(1), 188-198. https://doi.org/10.1002/jcsm.12369

Schuch, F. B., Vancampfort, D., Richards, J., Rosenbaum, S., Ward, P. B., & Stubbs, B. (2016). Exercise as a treatment for depression: a meta-analysis adjusting for publication bias. *Journal of psychiatric research*, *77*, 42-51. https://doi.org/10.1016/j.jpsychires.2016.02.023

Shah, R. C., Buchman, A. S., Leurgans, S., Boyle, P. A., & Bennett, D. A. (2012). Association of total daily physical activity with disability in community-dwelling older persons: a prospective cohort study. *BMC Geriatr*, *12*, 63. https://doi.org/10.1186/1471-2318-12-63

SHARE-ERIC. (2024a). Release Guide 9.0.0. *https://share-eric.eu/fileadmin/user_upload/Release_Guides/SHARE_release_guide_9-0-0.pdf*.

SHARE-ERIC. (2024b). *Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 8. Release version: 9.0.0*. https://doi.org/10.6103/SHARE.w8.900

SHARE-ERIC. (2024c). *Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 9. Release version: 9.0.0.* https://doi.org/10.6103/SHARE.w9.900

Simonsick, E. M., Newman, A. B., Visser, M., Goodpaster, B., Kritchevsky, S. B., Rubin, S., Nevitt, M. C., Harris, T. B., for the Health, A., & Study, B. C. (2008). Mobility Limitation in Self-Described Well-Functioning Older Adults: Importance of Endurance Walk Testing. *The Journals of Gerontology: Series A*, *63*(8), 841-847. https://doi.org/10.1093/gerona/63.8.841

Sjölund, B.-M., Wimo, A., Engström, M., & von Strauss, E. (2015). Incidence of ADL disability in older persons, physical activities as a protective factor and the need for informal and formal care–results from the SNAC-N project. *Plos one*, *10*(9), e0138901. https://doi.org/10.1371/journal.pone.0138901

Skotte, J., Korshoj, M., Kristiansen, J., Hanisch, C., & Holtermann, A. (2014). Detection of physical activity types using triaxial accelerometers. *J Phys Act Health*, *11*(1), 76-84. https://doi.org/10.1123/jpah.2011-0347

Steel, N., Huppert, F. A., McWilliams, B., & Melzer, D. (2003). Physical and Cognitive Function. In M. Marmot, J. Banks, R. Blundell, C. Lessof, & N. James (Eds.), *Health, wealth and lifestyles of the older population in England* (pp. 249-271). The Institute for Fiscal Studies.

Stemland, I., Ingebrigtsen, J., Christiansen, C. S., Jensen, B. R., Hanisch, C., Skotte, J., & Holtermann, A. (2015). Validity of the Acti4 method for detection of physical activity types in free-living settings: comparison with video analysis. *Ergonomics*, *58*(6), 953-965. https://doi.org/10.1080/00140139.2014.998724

Storeng, S. H., Sund, E. R., & Krokstad, S. (2018). Factors associated with basic and instrumental activities of daily living in elderly participants of a population-based survey: the Nord-Trøndelag Health Study, Norway. *BMJ Open*, *8*(3), e018942. https://doi.org/10.1136/bmjopen-2017-018942

Thrane, C. (2019). *Applied Regression Analysis : Doing, Interpreting and Reporting*. Taylor & Francis Group.

UNESCO. (2006). *International Standard Classification of Education ISCED 1997*. Retrieved 03.07.2024 from https://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-1997-en_0.pdf

Vaitkevicius, P. V., Ebersold, C., Shah, M. S., Gill, N. S., Katz, R. L., Narrett, M. J., Applebaum, G. E., Parrish, S. M., O'Connor, F. C., & Fleg, J. L. (2002). Effects of aerobic exercise training in community-based subjects aged 80 and older: A Pilot Study. *Journal of the American geriatrics society*, *50*(12), 2009-2013. https://doi.org/10.1046/j.1532-5415.2002.50613.x

van Allen, Z., Orsholits, D., & Boisgontier, M. P. (2024). Pre-stroke physical activity matters for functional limitations: A longitudinal case-control study of 12,860 participants. *medRxiv*. https://doi.org/10.1101/2023.09.14.23295576

Vaz de Almeida, M. D., Graca, P., Afonso, C., D'Amicis, A., Lappalainen, R., & Damkjaer, S. (1999). Physical activity levels and body weight in a nationally representative sample in the European Union. *Public Health Nutr*, *2*(1A), 105-113. https://doi.org/10.1017/s1368980099000154

Verbrugge, L. M., & Jette, A. M. (1994). The disablement process. *Social science & medicine*, *38*(1), 1-14. https://doi.org/10.1016/0277-9536(94)90294-1

WHO. (2020). *WHO Guidelines on Physical Activity and Sedentary Behaviour*. World Health Organization.

Wolinsky, F. D., Bentler, S. E., Hockenberry, J., Jones, M. P., Obrizan, M., Weigel, P. A. M., Kaskie, B., & Wallace, R. B. (2011). Long-term declines in ADLs, IADLs, and mobility among older Medicare beneficiaries. *BMC geriatrics*, *11*(1), 43. https://doi.org/10.1186/1471-2318-11-43

Wolinsky, F. D., Miller, D. K., Andresen, E. M., Malmstrom, T. K., & Miller, J. P. (2005). Further evidence for the importance of subclinical functional limitation and subclinical disability assessment in gerontology and geriatrics. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *60*(3), S146-S151. https://doi.org/10.1093/geronb/60.3.S146

Yokoya, T., Demura, S., & Sato, S. (2009). Three-year follow-up of the fall risk and physical function characteristics of the elderly participating in a community exercise class. *Journal of physiological anthropology*, *28*(2), 55-62. https://doi.org/10.2114/jpa2.28.55

7 Appendix

Appendix 1: Mean, standard error, and 95% confidence intervals of steps per day, time spent in intense activity, and self-reported frequency of vigorous activity by ADL and IADL status.

	ADL														
	Steps					**Intense Activities**					**Self-rated vigorously active**				
	N	mean	se	lb	ub	N	mean	se	lb	ub	N	%	se	lb	ub
ADL w8	66	5260	426	4410	6110	66	0.61	0.05	0.51	0.70	66	33.33	5.85	21.66	45.01
No ADL w8 - ADL w9	40	5291	563	4151	6430	40	0.66	0.07	0.52	0.79	40	27.50	7.15	13.04	41.96
No ADL w8 & w9	577	8070	156	7763	8376	577	0.95	0.02	0.91	0.99	577	61.18	2.03	57.19	65.17

	IADL														
	Steps					**Intense Activities** *hours*					**Self-rated vigorously active**				
	N	mean	se	lb	ub	N	mean	se	lb	ub	N	%	se	lb	ub
IADL w8	109	5369	347	4681	6057	109	0.63	0.04	0.55	0.71	109	23.85	4.10	15.72	31.98
No IADL w8 - IADL w9	51	6249	496	5253	7245	51	0.73	0.06	0.60	0.85	51	47.06	7.06	32.88	61.24
No IADL w8 & w9	523	8243	162	7925	8562	523	0.97	0.02	0.93	1.01	523	64.24	2.10	60.12	68.37

Data: SHARE Waves 8 & 9, Release 9.0.0
Note: se = standard error, lb = lower bound of 95 % confidence interval, ub = upper bound of 95 % confidence interval

Appendix 2: Logistic regression for the onset of ADL and IADL limitations: Average marginal effects

	ADL 1	ADL 2	ADL 3	IADL 1	IADL 2	IADL 3
Steps per day (in 1000)	-0.011 **			-0.009 *		
	(0.004)			(0.004)		
Intense Activity per day (hours)		-0.061 *			-0.059 +	
		(0.028)			(0.031)	
Vigorous activity (Ref: hardly ever, or never)						
At least once a month			-0.075 ***			-0.034
			(0.023)			(0.027)
Gender (Ref: Male)						
Female	-0.043 *	-0.042 +	-0.053 *	0.027	0.029	0.027
	(0.022)	(0.022)	(0.023)	(0.024)	(0.024)	(0.024)
Age (in years)	-0.000	0.000	0.000	0.004 *	0.004 *	0.005 **
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Education (Ref: Low)						
Medium	0.047 +	0.051 *	0.051 *	0.024	0.026	0.031
	(0.026)	(0.025)	(0.023)	(0.033)	(0.032)	(0.031)
High	0.018	0.019	0.026	0.035	0.036	0.041
	(0.028)	(0.027)	(0.027)	(0.040)	(0.040)	(0.039)
Make ends meet (Ref: With great difficulty)						
With some difficulty	-0.044	-0.045	-0.010	-0.131	-0.136	-0.128
	(0.053)	(0.054)	(0.043)	(0.094)	(0.094)	(0.096)
Fairly easily	-0.054	-0.057	-0.017	-0.194 *	-0.199 *	-0.189 +
	(0.053)	(0.055)	(0.043)	(0.096)	(0.096)	(0.098)
Easily	-0.036	-0.040	-0.002	-0.206 *	-0.209 *	-0.203 *
	(0.056)	(0.057)	(0.046)	(0.097)	(0.098)	(0.099)
Smoking (Ref: Never smoked)						
No current smoking	0.050 *	0.047 *	0.044 +	0.051 +	0.050 +	0.046 +
	(0.024)	(0.024)	(0.023)	(0.028)	(0.028)	(0.027)
Current smoking	0.007	0.009	0.019	0.074 +	0.076 +	0.085 *
	(0.025)	(0.026)	(0.029)	(0.040)	(0.040)	(0.042)
Risky alcohol (Ref: No)						
Yes	0.033	0.035	0.018	0.124	0.125	0.125
	(0.044)	(0.044)	(0.038)	(0.078)	(0.078)	(0.077)
Overweight (BMI >= 25) (Ref: No)						
Yes	-0.007	-0.005	-0.003	-0.043	-0.044	-0.042
	(0.022)	(0.022)	(0.022)	(0.028)	(0.028)	(0.027)
Stroke: ever diagnosed/ currently having (Ref: No)						
Yes	0.035	0.048	0.057	0.029	0.039	0.041
	(0.055)	(0.058)	(0.058)	(0.061)	(0.064)	(0.065)
Heart attack: ever diagnosed/ currently having (Ref: No)						
Yes	-0.036 +	-0.038 +	-0.039 +	0.021	0.018	0.017
	(0.020)	(0.020)	(0.020)	(0.040)	(0.039)	(0.040)
Chronic disease (Ref: None)						
One chronic disease	0.043 +	0.043 +	0.040	0.020	0.020	0.025
	(0.024)	(0.024)	(0.025)	(0.032)	(0.032)	(0.031)
Two or more chronic diseases	0.045 *	0.043 +	0.040 +	0.009	0.011	0.015
	(0.022)	(0.022)	(0.023)	(0.030)	(0.030)	(0.030)
Diff. picking up a small coin (Ref: No)						
Yes	0.144	0.131	0.110	0.278 *	0.274 *	0.221 +
	(0.108)	(0.104)	(0.089)	(0.140)	(0.139)	(0.131)
Diff. walking 100 m (Ref: No)						
Yes	0.053	0.081	0.089	0.048	0.057	0.075
	(0.047)	(0.054)	(0.055)	(0.061)	(0.063)	(0.069)
Memory test	-0.003	-0.005	-0.007	-0.002	-0.002	-0.004
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Numeracy test	0.004	0.004	0.004	0.013	0.013	0.014

	(0.009)	(0.009)	(0.009)	(0.011)	(0.011)	(0.011)
Country (Ref: Germany)						
Sweden	-0.050	-0.054	-0.058	0.015	0.015	0.018
	(0.044)	(0.045)	(0.048)	(0.055)	(0.056)	(0.058)
Spain	-0.070	-0.074	-0.092 +	-0.008	-0.015	-0.030
	(0.052)	(0.052)	(0.048)	(0.072)	(0.070)	(0.065)
Italy	-0.047	-0.058	-0.071	-0.053	-0.058	-0.064
	(0.050)	(0.048)	(0.047)	(0.048)	(0.048)	(0.047)
France	0.000	-0.003	-0.044	0.014	0.007	-0.011
	(0.057)	(0.058)	(0.051)	(0.062)	(0.062)	(0.059)
Denmark	-0.081 +	-0.079 +	-0.091 +	-0.010	-0.010	-0.011
	(0.044)	(0.048)	(0.048)	(0.070)	(0.072)	(0.074)
Belgium	-0.062	-0.059	-0.074 +	-0.037	-0.039	-0.037
	(0.042)	(0.045)	(0.045)	(0.050)	(0.051)	(0.053)
Czechia	-0.044	-0.047	-0.065	0.016	0.011	0.002
	(0.042)	(0.043)	(0.043)	(0.053)	(0.053)	(0.052)
Poland	-0.050	-0.053	-0.066	-0.037	-0.039	-0.042
	(0.042)	(0.043)	(0.043)	(0.047)	(0.048)	(0.048)
Slovenia	-0.080 *	-0.085 *	-0.085 *	-0.027	-0.031	-0.030
	(0.038)	(0.038)	(0.042)	(0.047)	(0.047)	(0.049)
Number of observations	617	617	617	574	574	574
Pseudo R^2	0.211	0.196	0.216	0.171	0.168	0.161

*** p<.001, ** p<.01, * p<.05, + p<.1

Data: SHARE Waves 8 & 9, Release 9.0.0

Note: Standard errors in parentheses.