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Mind and Medicine: Cognitive Decline and Healthcare Utilisation in Denmark

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Abstract

As populations age, cognitive impairment poses increasing challenges to healthcare systems. This paper examines how cognitive ability, measured via immediate and delayed word recall, predicts healthcare utilisation among adults aged 50 and older in Denmark. Using linked data from the Survey of Health, Ageing and Retirement in Europe (SHARE) and Danish administrative health records, we estimate the effect of cognitive decline on general practitioner (GP) visits and GP-related healthcare costs, disaggregated by sex. We find that being able to recall more words is consistently significantly associated with less frequent visits to the GP and lower healthcare expenditure for males, conditional on any use. In contrast, results for females are less consistent, with some evidence suggesting that better recall is associated with a higher frequency of GP visits. These results highlight sex-specific patterns in the relationship between cognitive function and primary care utilisation, with implications for resource allocation and dementia-related healthcare planning.

Keywords: disability; word recall; healthcare expenditure; healthy ageing

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1 Introduction

The global cost of dementia care now exceeds 1 trillion USD annually (Wimo et al., 2023), and is projected to double by 2030 (Alzheimer's Disease International, 2021). As populations age, cognitive impairment, which includes mild cognitive decline and dementia, will become more prevalent (Wu et al., 2017), posing challenges to healthcare systems. Cognitive impairment negatively affects the quality of life of older people by reducing autonomy, the ability to perform daily tasks, and participation in social activities (Hussenoeder et al., 2020). Moreover, individuals with cognitive impairment have distinct healthcare needs that often require more specialized care (Kracht et al., 2021), a higher reliance on primary care physicians (Fowler et al., 2012), and support for the management of prescription medication (Allen et al., 2023). Therefore, understanding how cognitive impairment is associated with healthcare utilisation is critical for informing resource allocation, improving care delivery, and shaping interventions that improve health outcomes, while controlling costs.

This paper estimates the association between cognitive impairment and healthcare utilisation of individuals aged 50 years and older in Denmark. We use data on immediate and delayed word recall from the Survey of Health, Ageing, and Retirement in Europe (SHARE) as a proxy for cognitive ability (Bonsang et al., 2012; Mazzonna and Peracchi, 2012). By linking SHARE data to the Danish administrative health registries, we analyse the relationship between cognitive decline and key healthcare utilisation metrics, including the number of general practitioner (GP) visits, and healthcare expenditure associated with these visits.

The direction of this relationship is theoretically ambiguous; on the one hand, individuals experiencing cognitive decline may require greater medical care due to their condition, while on the other hand, cognitive impairment may limit individuals' awareness of their health status, leading to little or no change in their healthcare-seeking behaviour. Additionally, estimating the causal effect of cognitive decline on healthcare utilisation is challenging due to potential simultaneity bias, as unobserved underlying health conditions may concurrently influence both cognitive functioning and healthcare usage.

Patterns of cognitive decline differ between males and females (Levine et al., 2021). Additionally, males and females engage with healthcare systems in distinct ways, which may lead to systematic differences in measured healthcare utilisation (Juel and Christensen, 2008; Oksuzyan et al., 2011). Moreover, in Denmark, females live almost four years longer than males (Statistics Denmark, 2025), but tend to experience poorer health at older ages (Aaskoven et al., 2024). To account for these differences, we stratified our analyses by sex. Our analysis reveals a clear sex-specific pattern in the relationship between cognitive performance and healthcare utilisation. Among males, higher delayed word recall is significantly associated with less frequent GP visits and lower GP-related healthcare costs, conditional on any use. Our findings for females, however, are less consistent: the unbalanced panel shows no significant relationship or even negative associations, while the balanced panel reveals a positive link between cognitive performance and GP visit frequency. These findings suggest that poorer memory performance may drive more intensive use of primary care services among older males, with important implications for targeting interventions and anticipating future healthcare demand.

Our findings contribute to previous empirical research on cognitive impairment and healthcare utilisation which yields mixed results. For example, Walsh et al. (2003) found that lower cognitive functioning was associated with lower utilisation of outpatient services in the United States. In a European setting, Gannon et al. (2018) found that each additional word recalled was associated with fewer visits to a medical doctor, though Lugo-Palacios and Gannon (2017) find additional words recalled to be associated with higher rates of hospitalization. Like our study, Gannon et al. (2018) and Lugo-Palacios and Gannon (2017) use SHARE data to measure cognitive decline, but unlike our study, they use self-reported healthcare utilisation data, which may be prone to reporting biases – a particular concern among individuals experiencing cognitive impairment. Studies also find differences when taking sociodemographic and socioeconomic indicators into account, as in Pereira et al. (2022), who find higher emergency and ambulance utilisation among Black people with dementia than White, but higher non-emergency hospitalization among White people with dementia than Black in New Orleans. Among dementia patients in Italy, Cristofalo et al. (2025) found there to be persistent educational disparities in emergency care, but not in all-cause hospitalizations.

The paper is organised as follows. Section 2 introduces the data and analytical sample, and defines key variables for measures of cognitive decline, and healthcare utilisation. Section 3 outlines the two-part model. Section 4 presents the main results. Section 5 discusses the broader implications and concludes.

2 Data

We use data from SHARE (Börsch-Supan et al., 2013), linked to Danish registries via SHARE-RegLink. SHARE-Reglink presents a unique opportunity to estimate the association of cognitive ageing on healthcare utilisation for three reasons. First, SHARE provides detailed longitudinal health and socioeconomic information on non-institutionalized individuals aged 50 and older. Second, SHARE includes in-person recording of consistent measures for cognitive functioning (See Section 2.2). Third, by linking SHARE to Danish register data, the SHARE-Reglink provides objective measures of healthcare utilisation through public health insurance data (See Section 2.3). Initiated in 2004 (Wave 1), SHARE is conducted biennially, with refreshment samples incorporated to mitigate panel attrition due to mortality and non-response. We used data from Waves 1 (2004) through 6 (2015) to maximize the sample of respondents with complete information on healthcare utilisation, cognitive measures, and relevant covariates, focusing on individuals surveyed in at least two waves. We excluded Wave 3 because it focuses on life history interviews rather than standardized regular questionnaires used in the other waves.

2.1 Analytical Sample

For our main analyses and results, we use an unbalanced sample, in which survey participants have been observed at least twice over the five waves.

The summary statistics for males and females are presented in Panel A and Panel B

Table 1: Descriptive statistics over waves

Variable	**Wave 1**	**Wave 2**	**Wave 4**	**Wave 5**	**Wave 6**
Panel A: Men	**N=548**	**N=928**	**N=933**	**N=1,564**	**N=1,448**
Cognitive measures					
Immediate word recall	5.34	5.51	5.48	5.61	5.64
Delayed word recall	4.05	4.23	4.35	4.35	4.47
Healthcare utilization					
GP visits (mean of count)	33	53	28	24	21
GP costs	2,604	4,692	2,595	2,182	1,954
Health status					
Pre-existing conditions	291 (53%)	398 (43%)	403 (43%)	734 (47%)	716 (49%)
Grip strength	48	45	48	47	47
Socioeconomic characteristics					
Still working	248 (45%)	417 (45%)	434 (47%)	728 (47%)	617 (43%)
Married/partnered	393 (72%)	716 (77%)	701 (75%)	1,206 (77%)	1,104 (76%)
Demographics					
Age (years)	62	63	64	65	66
Time to Interview (months)	35	48	25	22	19
Panel B: Women	**N = 606**	**N=1,063**	**N=1,056**	**N=1,811**	**N=1,683**
Cognitive measures					
Immediate word recall	5.80	5.99	5.96	6.05	6.05
Delayed word recall	4.54	4.87	4.97	4.89	4.97
Healthcare utilization					
GP visits (mean of count)	44	60	33	27	24
GP costs	3,235	5,003	2,845	2,408	2,162
Health status					
Pre-existing conditions	353 (58%)	529 (50%)	533 (50%)	911 (50%)	915 (54%)
Grip strength	28	26	28	28	28
Socioeconomic characteristics					
Still working	220 (36%)	414 (39%)	420 (40%)	710 (39%)	602 (36%)
Married/partnered	368 (61%)	692 (65%)	712 (67%)	1,239 (68%)	1,111 (66%)
Demographics					
Age (years)	63	64	64	64	66
Time to Interview (months)	36	46	25	22	19

Note: Unbalanced Panel, Continuous variables presented as means; categorical variables as n (%). GP costs in Danish Kroner (DKK).

in Table 1. Females consistently have better cognitive function than males, with higher mean scores in immediate and delayed word recall at each wave. For instance, immediate recall averages range from 5.80 to 6.05 for females, compared to 5.34 to 5.64 for males. Healthcare utilisation, measured by GP visits and costs, is also higher among females, who report more frequent visits and, therefore, greater associated costs in all waves. However, both sexes exhibit a decline in GP visits and costs over time. Regarding health status, a slightly larger proportion of females report pre-existing conditions (50–58%) than males (43–53%), while males demonstrate greater grip strength, an indicator of physical health, consistent across waves. Socioeconomic indicators show that males are more likely to be married or partnered and to remain employed, with marriage rates above 70% and employment rates near 45%, compared to approximately 60–68% partnered and 36–40% working among females. The groups have similar ages across waves, with mean ages increasing from early-sixties to mid-sixties. These findings suggest gender-specific patterns in cognitive function, health status, and healthcare engagement in this older population. The sample sizes within each wave for in both tables reflect changing samples due to attrition, death and refreshment sampling in SHARE. We condition on time to interview (in months) in our regressions to account for variation in the timing of cognitive assessments for each individuals.

2.2 Measures of Cognitive Ageing

We used two measures of cognitive function in our analysis: immediate word recall and delayed word recall. Immediate word recall captures the number of words, out of a total of ten, that an individual can remember immediately after hearing them.[4] Delayed word recall measures the number of words an individual can remember from the same list ten minutes after initial presentation. Notably, during the ten-minute delay, the interviewer continues administering the questionnaire, minimizing the likelihood of conscious rehearsal by respondents.

Figure 1 presents the distribution of the number of words (out of 10) recalled after

[4] In Waves 1 and 2, the same word list was used for all respondents, whereas from Waves 4 onwards, participants were randomly assigned one of four different sets of ten words.

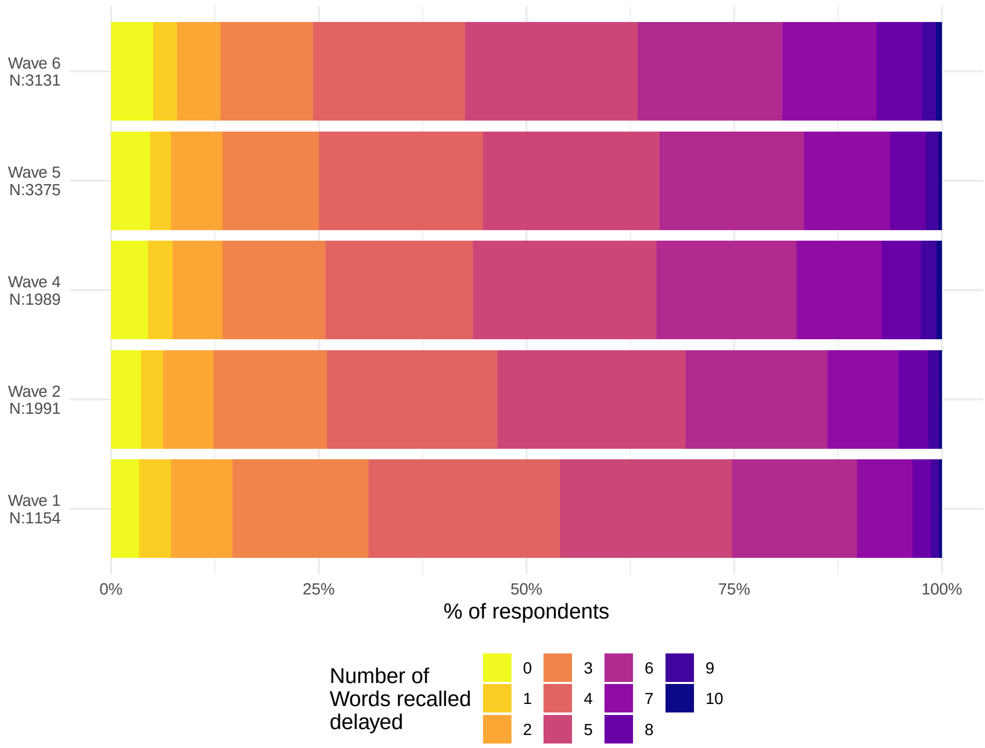

Figure 1: Distribution of number of words recalled after 10 minute delay by wave.

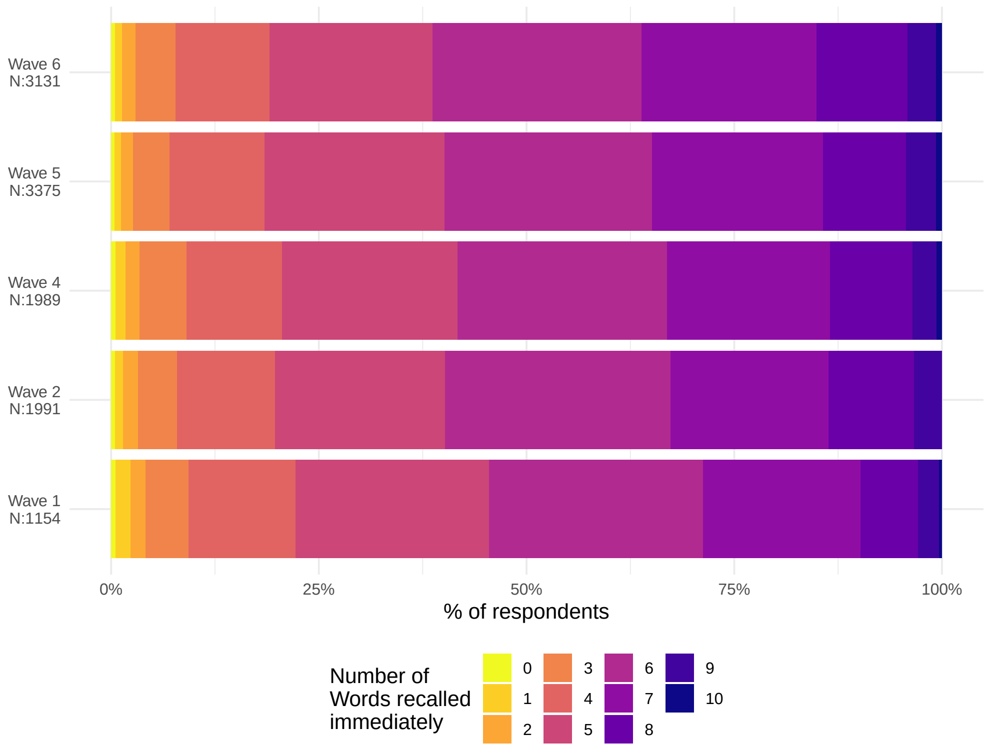

Figure 2: Distribution of number of words immediately recalled by wave.

a 10-minute delay across survey waves. A clear decline in recall performance is evident over time, consistent with cognitive ageing in the panel. This pattern remains evident despite panel attrition due to mortality and transitions into long-term care, as well as the introduction of refreshment samples across waves. In each wave, fewer than 5% of respondents recalled either zero or all ten words. Figure 2 displays the analogous distribution for immediate recall. As expected, the share of respondents recalling no words is lower, while the share recalling all 10 is higher. Aside from these differences at the extremes, the two measures followed similar distributions. We therefore focused on delayed recall in our main analysis, as it is less prone to learning effects across waves. In Section 4.2, we show that our results are robust to using immediate recall as an alternative measure.

2.3 Measures of Healthcare Utilisation

We measure healthcare utilisation using two outcomes. The first is the annual number of visits to a general practitioner (GP), as recorded in public health insurance data. The second is the corresponding annual expenditure on GP visits, measured in Danish Kroner (DKK). These expenditures refer to expenditures by the state, and not individual expenditures.

Figure 3 displays the distribution of general practitioner (GP) visits by sex, pooled across all waves. Consistent with prior research, 15% of males in the analytical sample never visited a GP during the study period, compared with 10% of females. The distribution for females is more skewed to the right, indicating that, on average, females in the analytical sample visited their GP more frequently than males. Over the study period, the mean number of visits was 35 for females and 30 for males. A greater proportion of males reported no GP visits compared to females. Figure 4 shows the distribution of GP-related healthcare expenditures by sex, pooled across all waves. At the 10th percentile, males are more likely to incur no GP-related costs during the study period, whereas at the 5th percentile, females are less likely to incur none. The cost distribution for females is also slightly more right-skewed, reflecting higher average spending relative to

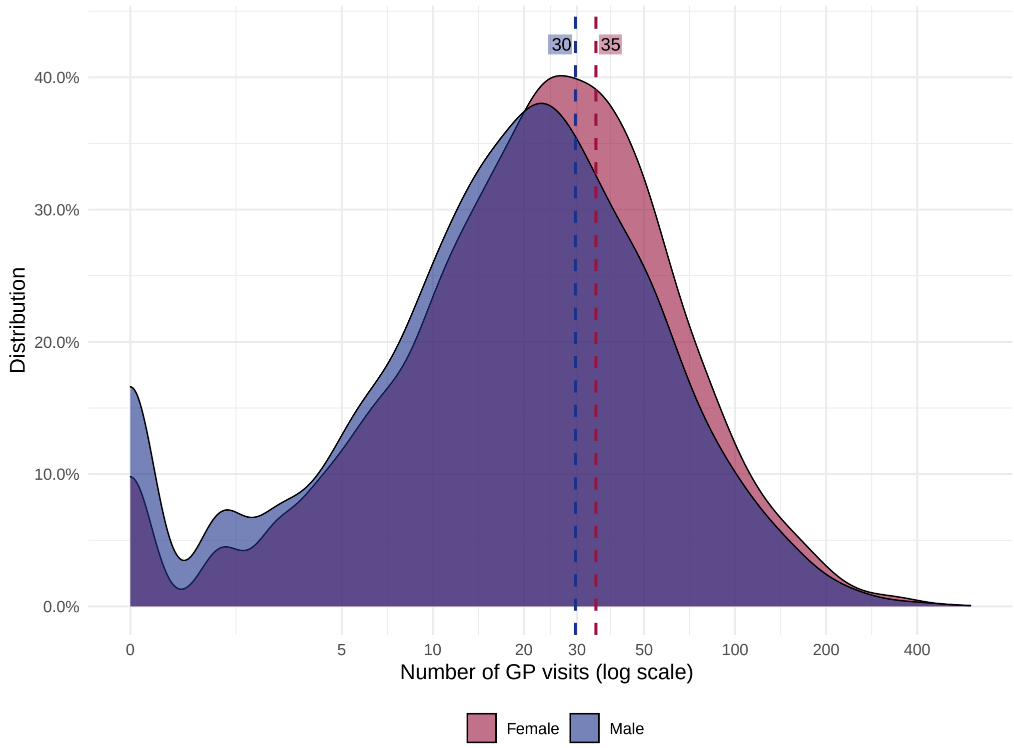

Figure 3: Distribution of number of visits to GP by sex.

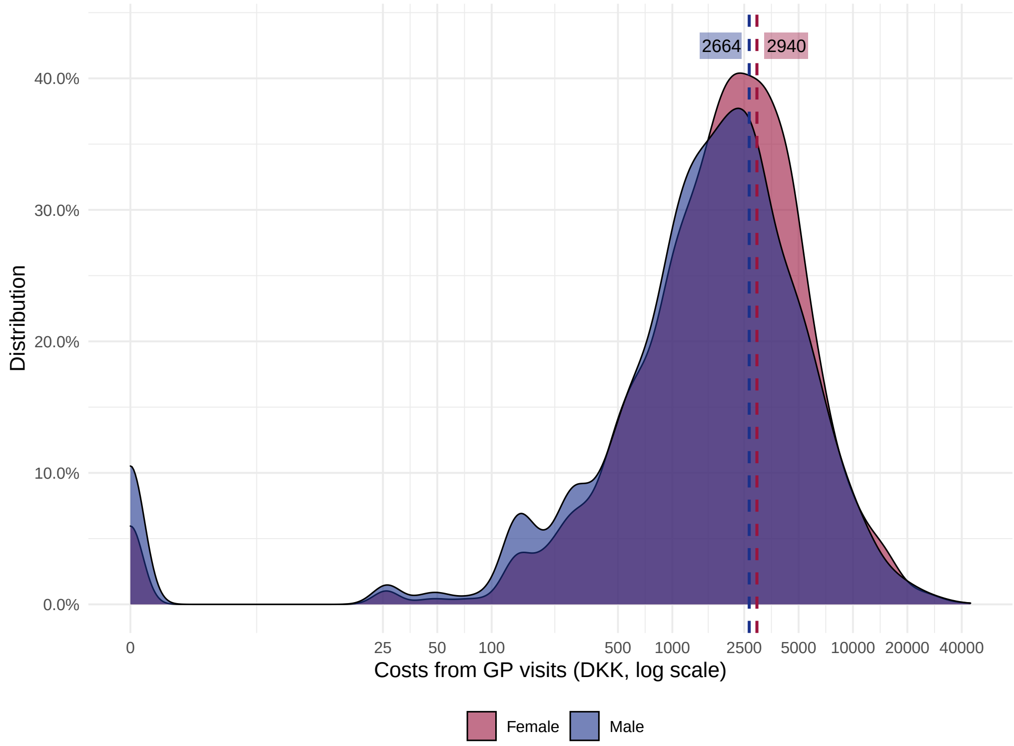

Figure 4: Distribution of costs from GP visits by sex.

males. Mean GP-related expenditure was higher for females, and approximately 10% of the sample incurred no GP-related costs over the study period.

Figure 5 presents a box plot of GP-related healthcare costs by memory recall ability, pooled across all survey waves. Note that top and bottom 5 percent of values are excluded and individuals who remembered 9 or 10 words were merged into one group due to privacy. Boxes represent the interquartile range, with the median marked by a horizontal line; whiskers indicate the 2.5th to 97.5th percentiles. For both males and females, average GP costs increase consistently as memory recall declines. Figure 6 shows a similar pattern for the number of GP visits. A clear inverse gradient emerges: individuals with lower recall scores tended to visit the GP more frequently. This relationship holds for both sexes. Consistent with previous literature, females have higher GP utilisation than males at each level of memory recall.

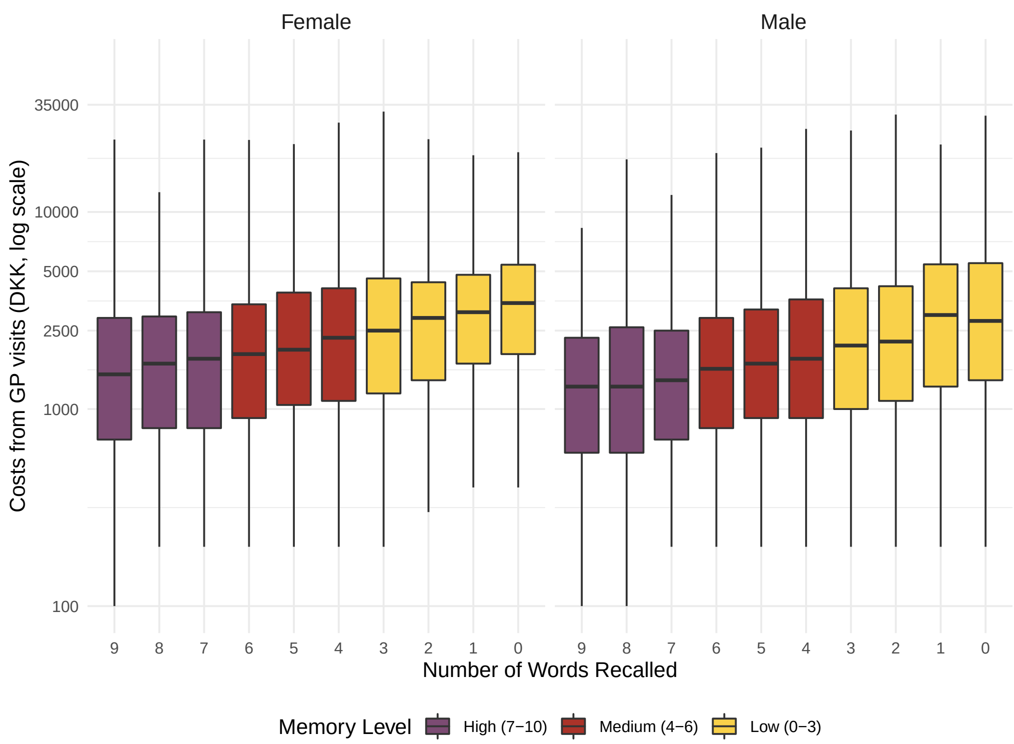

Figure 5: GP costs by number of words recalled

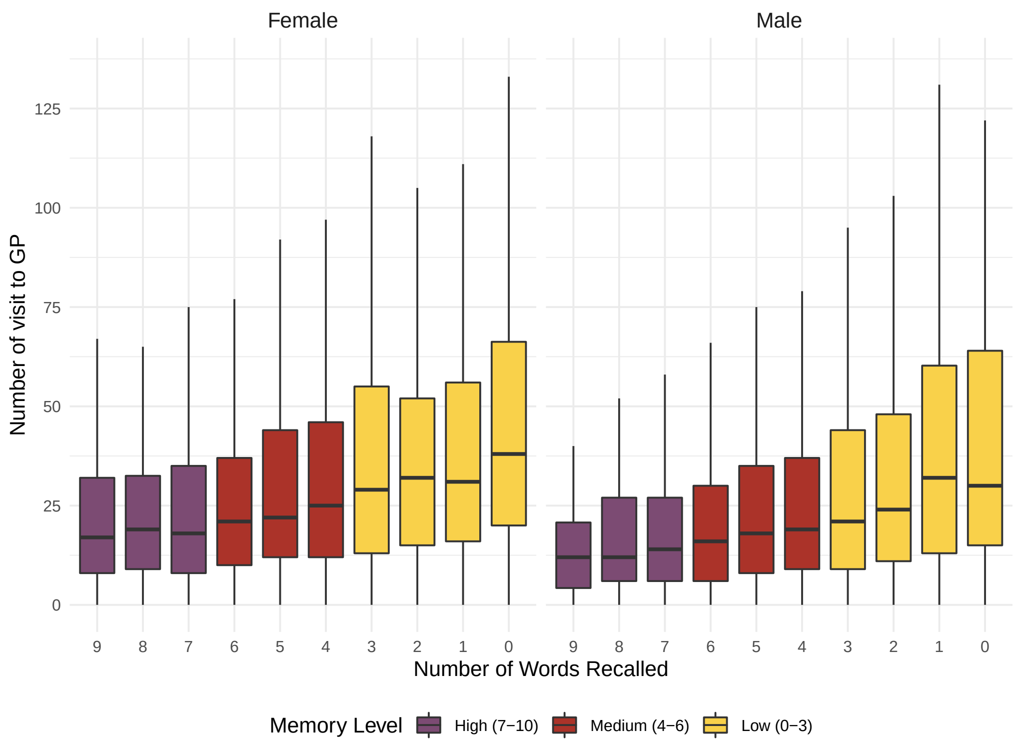

Figure 6: Number of visits to GP by number of words recalled

3 Methods

Our two outcomes of interest, to proxy for cognitive function over time, are: (1) frequency of general practitioner visits (GP) and (2) the related costs of these visits in Danish kroner (DKK).

Healthcare utilisation typically exhibits a zero-inflated distribution—many individuals incur no costs during the observation period—and is right-skewed, with a small share accounting for disproportionately high costs. This pattern poses distinct challenges. In our sample, we confirm a clear sex-specific difference: Males are more likely than females to report zero utilization. Following the health expenditure literature, we adopt a two-part modelling framework (Deb and Norton, 2018).

To address these methodological challenges, we employ a two-part random-effects approach for both outcomes. GP visits are modelled using a Poisson random-effects specification, which accommodates the count nature of the data while capturing individual heterogeneity. For costs, we adopt a two-part log-normal framework that separately models (i) the probability of incurring any cost and (ii) the level of expenditure among individuals with positive costs. In both cases, random effects account for within-person correlation over time.

Following the annotation from Farewell et al. (2017a), let Y_{ij} be a semi-continuous variable for the i'th individual, at time j. This outcome can be represented by two variables of occurrence.

$$Z_{ij} = \begin{cases} 0 & \text{if } Y_{ij} = 0 \\ 1 & \text{if } Y_{ij} > 0 \end{cases} \tag{1}$$

This is then combined with an intensity variable, where when $Y_{ij} > 0$ then $g(Y_{ij})$ where $g(\cdot)$ is a transformation function, which makes Y_{ij} approximately normally distributed, with a subject and time-specific mean, and constant variance. Z_{ij} is assumed to follow a random effects logistic regression.

$$\text{logit}\{Pr(Z_{ij} = 1|\mathbf{X}_{ij}, U_i)\} = \mathbf{X}_{ij}\boldsymbol{\theta} + U_i \tag{2}$$

Here, $\mathbf{X}_{ij}$ is a covariate vector, $\boldsymbol{\theta}$ is a regression coefficient vector, U_i is the random intercept at the individual or subject level. The intensity variable $g(Y_{ij})$ follows a mixed linear model:

$$g(Y_{ij})|Y_{ij} > 0, \mathbf{X}^*_{ij} = \mathbf{X}^*_{ij}\boldsymbol{\beta} + V_i + \epsilon_{ij} \tag{3}$$

Here, $\mathbf{X}^*_{ij}$ is a covariate vector, $\boldsymbol{\beta}$ is a regression coefficient vector, V_i is the random intercept at the individual or subject level and ϵ_{ij} is the error term.

The assumption of correlated random effects can be understood as, the use or non-use of healthcare services is related to the level of usage at that and any other time points Farewell et al. (2017b). When modeling healthcare expenditure, it is general practice that variables should be consistent in both the zero and non-zero part of the model Deb and Norton (2018). We do not use weights as sampling probabilities only vary with the explanatory variables from SHARE data and not with the outcome variables recorded in the Danish registry data (Solon et al., 2015). The two-part GP count data model is similar to the GP cost data model except that it uses a poisson distribution to model the count when when $Y_{ij} > 0$.

4 Results

4.1 Delayed Recall

Table 2 presents the two-part models of GP visit frequency in Panel A and GP costs in Panel B for female participants. Delayed word recall showed no significant association with either the probability of having any GP visits ($p = 0.528$) or the number of visits among users ($p = 0.974$). Delayed word recall was not significantly associated with the likelihood of incurring any healthcare costs ($p = 0.736$) or with the level of costs among users ($p = 0.200$). Our results are somewhat surprising, as Figure 5 suggests a possible association; however, this relationship appears to disappear once we adjust for covariates such as age, education, and other relevant factors. These findings suggest that, for females, memory performance is not strongly associated with either the number of visit to the GP or intensity of GP-related healthcare expenditure.

Table 3 presents the two-part models of GP visits in Panel A and GP Costs in Panel B for male participants. Delayed word recall is not significantly associated with the probability of any GP visits ($p = 0.338$), but is negatively and significantly associated with the number of GP visits ($p < 0.001$). Conditional on having any GP visits, each additional word recalled was associated with a 0.017 decrease in the number of GP visits for males. Delayed recall was not significantly associated with the likelihood of incurring any healthcare costs ($p = 0.234$), but was significantly and negatively associated with the level of costs among those with positive expenditure ($p = 0.001$). Conditional on incurring positive GP costs, each additional word recalled was associated with an approximate 2.4% reduction in GP expenditures. These findings indicate that, for males, better delayed memory performance is associated with a lower frequency of GP visits and lower healthcare expenditure intensity, conditional on any use.

Table 2: Two-part models for Females

Panel A: GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed Word recall	-0.040	0.063	0.528	0.000	0.002	0.974
Age	-0.054	0.022	0.012	0.018	0.001	<0.001
Medium education	0.106	0.289	0.715	0.169	0.037	<0.001
Low education	0.056	0.340	0.870	0.292	0.038	<0.001
Not married	-0.221	0.281	0.432	0.084	0.015	<0.001
Pre-existing cond.	-1.090	0.287	<0.001	0.072	0.007	<0.001
Not working	-0.144	0.323	0.656	0.041	0.011	<0.001
Grip strength	0.086	0.155	0.578	-0.009	0.006	0.108
Time to Interview	-0.978	0.199	<0.001	0.375	0.003	<0.001
Random effects		Variance			Variance	
Individual-level		4.831			0.540	
Correlation between random effects: -0.808						
Panel B: GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed Word recall	-0.022	0.066	0.736	-0.008	0.006	0.200
Age	-0.062	0.023	0.006	0.017	0.002	<0.001
Medium education	0.140	0.310	0.652	0.125	0.042	0.003
Low education	0.110	0.362	0.762	0.243	0.046	<0.001
Not married	-0.206	0.303	0.496	0.065	0.033	0.050
Pre-existing cond.	-1.158	0.288	<0.001	0.216	0.023	<0.001
Not working	-0.150	0.331	0.651	0.133	0.031	<0.001
Grip strength	0.094	0.164	0.565	-0.056	0.016	<0.001
Time To Interview	-1.160	0.216	<0.001	0.417	0.009	<0.001
Random effects		Variance			Variance	
Individual-level		5.689			0.476	
Correlation between random effects: -0.773						

Note: $n = 2,095$ individuals with 6,222 observations. Unbalanced panel

Table 3: Two-part models for Males

Panel A: GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed Word recall	0.049	0.051	0.338	-0.017	0.002	<0.001
Age	-0.108	0.018	<0.001	0.032	0.001	<0.001
Medium education	-0.062	0.224	0.783	0.030	0.040	0.447
Low education	0.072	0.287	0.803	0.078	0.050	0.114
Not married/partnered	0.175	0.219	0.423	0.075	0.020	<0.001
Pre-existing condition	-0.935	0.218	<0.001	0.099	0.009	<0.001
Not working	0.384	0.245	0.117	0.067	0.012	<0.001
Grip strength	0.065	0.123	0.596	-0.006	0.007	0.450
Time to Interview	-1.076	0.160	<0.001	0.378	0.003	<0.001
Random effects		Variance			Variance	
Individual-level		3.869			0.626	
Correlation between random effects: -0.844						
Panel A: GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed Word recall	0.062	0.052	0.234	-0.024	0.007	0.001
Age	-0.111	0.018	<0.001	0.034	0.003	<0.001
Medium education	-0.250	0.229	0.275	0.152	0.046	0.001
Low education	0.002	0.292	0.996	0.151	0.056	0.006
Not married	0.202	0.230	0.379	0.017	0.042	0.692
Pre-existing cond.	-1.162	0.221	<0.001	0.272	0.027	<0.001
Not working	0.287	0.248	0.248	0.123	0.035	<0.001
Grip strength	0.128	0.127	0.313	-0.046	0.020	0.022
Time to Interview	-1.162	0.164	<0.001	0.427	0.011	<0.001
Random effects		Variance			Variance	
Individual-level		3.851			0.533	
Correlation between random effects: -0.867						

Note: $n = 1,810$ individuals with 5,426 observations. Unbalanced panel

4.2 Immediate Recall

Immediate and delayed recall tests capture distinct dimensions of cognitive function. Immediate recall reflects short-term memory and attentional control, which are closely tied to everyday behaviours such as scheduling appointments, following medical instructions, and managing medications. These functions may bear directly on healthcare utilization, particularly in the early stages of cognitive decline. In contrast, delayed recall measures longer-term memory consolidation and retrieval, processes that may degrade later and affect behaviour less immediately.

Table 4: Two-part model for Females

Panel A: GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.059	0.080	0.465	-0.008	0.002	<0.001
Age	-0.057	0.023	0.011	0.017	0.001	<0.001
Medium education	0.106	0.308	0.731	0.169	0.037	<0.001
Low education	0.094	0.362	0.796	0.290	0.038	<0.001
Not married	-0.222	0.297	0.455	0.083	0.016	<0.001
Pre-existing cond.	-0.960	0.288	<0.001	0.071	0.007	<0.001
Not working	-0.040	0.332	0.904	0.042	0.011	<0.001
Grip strength	0.007	0.162	0.965	-0.009	0.006	0.126
Temporal Control	-1.038	0.205	<0.001	0.375	0.003	<0.001
Random effects		Variance			Variance	
Individual-level		5.795			0.553	
Correlation between random effects: -0.754						
Panel B: GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.061	0.081	0.449	-0.013	0.007	0.056
Age	-0.058	0.023	0.011	0.017	0.002	<0.001
Medium education	0.184	0.310	0.554	0.121	0.042	0.004
Low education	0.198	0.363	0.586	0.238	0.046	<0.001
Not married	-0.187	0.302	0.535	0.063	0.033	0.055
Pre-existing cond.	-1.182	0.289	<0.001	0.216	0.023	<0.001
Not working	-0.192	0.331	0.563	0.135	0.031	<0.001
Grip strength	0.100	0.164	0.543	-0.057	0.016	<0.001
Temporal Control	-1.091	0.208	<0.001	0.417	0.010	<0.001
Random effects		Variance			Variance	
Individual-level		5.666			0.476	
Correlation between random effects: -0.782						

Note: $n = 2,094$ individuals with 6,219 observations.

Table 5: Two-part model for males

Panel A: GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.058	0.059	0.327	-0.026	0.003	<0.001
Age	-0.109	0.018	<0.001	0.031	0.001	<0.001
Medium education	-0.061	0.225	0.788	0.025	0.040	0.538
Low education	0.078	0.287	0.785	0.066	0.050	0.184
Not married	0.169	0.219	0.441	0.075	0.020	<0.001
Pre-existing cond.	-0.940	0.218	<0.001	0.097	0.009	<0.001
Not working	0.396	0.245	0.107	0.066	0.012	<0.001
Grip strength	0.054	0.124	0.663	-0.005	0.007	0.512
Temporal Control	-1.084	0.160	<0.001	0.379	0.003	<0.001
Random effects		Variance			Variance	
Individual-level		3.862			0.626	
Correlation between random effects: -0.843						
Panel B: GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.071	0.060	0.236	-0.036	0.008	<0.001
Age	-0.113	0.019	<0.001	0.033	0.003	<0.001
Medium education	-0.255	0.229	0.267	0.147	0.046	0.001
Low education	0.003	0.292	0.993	0.139	0.056	0.012
Not married	0.200	0.230	0.384	0.013	0.042	0.762
Pre-existing cond.	-1.171	0.222	<0.001	0.271	0.027	<0.001
Not working	0.303	0.248	0.223	0.119	0.035	<0.001
Grip strength	0.113	0.127	0.374	-0.045	0.020	0.024
Temporal Control	-1.173	0.164	<0.001	0.427	0.011	<0.001
Random effects		Variance			Variance	
Individual-level		3.853			0.534	
Correlation between random effects: -0.869						

Note: $n = 1,809$ individuals with 5,421 observations.

We examine the effect of immediate word recall on healthcare utilisation to assess whether our results were sensitive to our measure of cognitive ageing. Overall, the associations in Table 4 for females and 5 for males are consistent with the results observed for delayed recall, with stronger associations for males than for females. Among females, the associations were smaller, but remained statistically significant for both costs (–0.013, $p = 0.056$) and visits (–0.008, $p < 0.001$). Immediate word recall was significantly and negatively associated with both GP-related healthcare costs (–0.036, $p < 0.001$) and visit frequency (–0.026, $p < 0.001$) among males. These associations support the main model results by showing that better memory performance is associated with lower intensity of healthcare utilisation, particularly for males. Unlike the estimates using delayed recall, we find a significant negative relationship between better performance on immediate recall and healthcare utilisation with lower effect sizes for females than for males.

The stronger and more consistent associations observed between immediate recall and healthcare use—especially among males—suggest that short-term cognitive efficiency plays a more salient role in shaping health-related behaviours. The weaker or null effects for delayed recall, particularly among females, may reflect both the delayed onset of functional impairment and sex-specific patterns in healthcare engagement. These findings underscore the importance of selecting cognitively relevant measures when examining the behavioural consequences of cognitive decline.

4.3 Balanced Panel

To address concerns that our findings may be influenced by differential mortality or attrition across sexes, we replicated the analyses using a balanced panel.

Table 6 describes results for 800 females (2,400 observations) observed between wave 4 and wave 6. We use waves 4 and 6 to maximise the number of respondents observed between two waves. The results, presented broadly reinforce the main conclusions. Among females, delayed recall did not have a statistically significant association with healthcare costs (–0.006, $p = 0.556$), but, unexpectedly, had a positive association with GP visit frequency (0.022, $p < 0.001$).

The negative marginal effect on healthcare costs remained statistically significant for males (–0.029, $p = 0.012$) as did the negative effect on GP visit frequency (–0.015, p < 0.001). This divergence underscores a gender-specific relationship between cognitive function and healthcare utilisation.

Similarly, we examine the effect of immediate word recall on healthcare utilisation in a balanced panel. This includes 283 females (1415 observations) and 256 males (1280 observations) observed between wave 1 and wave 6. For females, immediate recall was not associated with healthcare costs (–0.004, $p = 0.809$), but was positively associated

Table 6: Two-part models for Females

Panel A - GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed word recall	-0.026	0.106	0.809	0.022	0.004	<0.001
Age	-0.087	0.045	0.056	0.017	0.002	<0.001
Medium education	0.474	0.490	0.333	0.311	0.061	<0.001
Low education	-0.077	0.634	0.904	0.273	0.062	<0.001
Not married	-0.333	0.502	0.507	-0.012	0.027	0.643
Pre-existing cond.	-1.399	0.539	0.009	-0.026	0.014	0.066
Not working	-0.411	0.580	0.479	-0.029	0.022	0.182
Grip strength	0.017	0.276	0.950	-0.061	0.012	<0.001
Time to Interview	-2.546	0.687	<0.001	0.625	0.020	<0.001
Random effects		Variance			Variance	
Individual-level		5.651			0.521	
Correlation between random effects: -0.741						
Panel B - GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed word recall	0.005	0.106	0.964	-0.006	0.009	0.556
Age	-0.087	0.044	0.048	0.015	0.004	<0.001
Medium education	0.631	0.487	0.195	0.193	0.063	0.002
Low education	0.032	0.621	0.960	0.238	0.069	<0.001
Not married	-0.351	0.503	0.485	0.007	0.051	0.894
Pre-existing cond.	-1.673	0.529	0.002	0.155	0.037	<0.001
Not working	-0.552	0.571	0.334	0.152	0.051	0.003
Grip strength	0.079	0.275	0.775	-0.101	0.027	<0.001
Time to Interview	-2.474	0.676	<0.001	0.717	0.050	<0.001
Random effects		Variance			Variance	
Individual-level		5.042			0.435	
Correlation between random effects: -0.692						

Note: $n = 800$ individuals with 2,400 observations. Balanced panel with waves 4-6

with GP visits (0.011, $p = 0.006$) as shown in Table 8 in the Appendix. Males exhibited significant negative associations for both healthcare costs (–0.036, $p = 0.025$) and GP visits (–0.023, $p < 0.001$) as shown in Table 9 in the Appendix. These findings confirm that better cognitive performance is associated with lower healthcare utilisation, primarily among males, while the association is less consistent for females.

In the balanced sample, the unexpected positive association between delayed recall and GP visits among females likely reflects selection effects and differences in healthcare behaviour. By restricting the sample to individuals observed across multiple waves, the balanced panel disproportionately retains healthier and more cognitively intact women,

Table 7: Two-part model for Males

Panel A - GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed word recall	0.151	0.079	0.056	-0.015	0.004	<0.001
Age	-0.128	0.029	<0.001	0.030	0.003	<0.001
Medium education	-0.500	0.346	0.148	0.100	0.070	0.151
Low education	0.476	0.418	0.255	0.130	0.082	0.111
Not married	0.000	0.335	0.999	0.081	0.038	0.032
Pre-existing cond.	-1.234	0.382	0.001	0.073	0.016	<0.001
Not working	1.346	0.391	<0.001	-0.026	0.025	0.303
Grip strength	0.074	0.197	0.709	0.003	0.015	0.848
Time to Interview	-2.067	0.515	<0.001	0.603	0.024	<0.001
Random effects		Variance			Variance	
Individual-level		3.383			0.633	
Correlation between random effects: -0.923						
Panel B - GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Delayed word recall	0.181	0.082	0.027	-0.029	0.012	0.012
Age	-0.137	0.030	<0.001	0.031	0.005	<0.001
Medium education	-0.619	0.354	0.081	0.138	0.072	0.058
Low education	0.370	0.427	0.387	0.168	0.091	0.064
Not married	0.087	0.356	0.808	0.012	0.068	0.857
Pre-existing cond.	-1.447	0.380	<0.001	0.300	0.044	<0.001
Not working	1.299	0.402	0.001	0.112	0.060	0.063
Grip strength	0.155	0.202	0.444	-0.019	0.034	0.577
Time to Interview	-2.201	0.528	<0.001	0.665	0.061	<0.001
Random effects		Variance			Variance	
Individual-level		3.486			0.548	
Correlation between random effects: -0.953						

Note: $n = 697$ individuals with 2,091 observations. Balanced panel with waves 4-6

potentially excluding those with cognitive decline who might use healthcare differently. Among this healthier subset, better memory performance may correlate with greater health awareness, health literacy, and more proactive engagement with primary care services—resulting in more frequent GP visits. This contrasts with the unbalanced sample, where greater cognitive and health variability may obscure or reverse this relationship. Rather than indicating reduced healthcare need, better cognitive function in females may facilitate more regular and informed interaction with the healthcare system. Taken together, the balanced panel estimates reinforce our primary results, suggesting that cognitive decline is a more robust predictor of healthcare utilisation and expenditures for males than for females, even when accounting for differential attrition or mortality.

5 Discussion

This study explores the complex, sex-specific associations between cognitive function, captured through immediate and delayed word recall, and healthcare utilisation. Among males, we found that better cognitive performance predicts lower frequency of GP visits and lower healthcare expenditures across multiple model specifications. This relationship demonstrates consistency, suggesting that cognitive decline may serve as an early indicator of broader health deterioration requiring increased medical attention. In contrast, our findings for females are less consistent and reveal methodological sensitivities: initial models show no significant or even negative relationships, while balanced panel analyses reveal a positive association between cognitive function and GP visits. This divergence likely reflects sample selection and survivorship biases, as healthier females with better cognitive performance disproportionately remain in balanced panels over time.

These findings align with Lugo-Palacios and Gannon (2017), who find that individuals with cognitive impairment tend to have more hospitalisations, though they do not stratify by sex. Gannon et al. (2018), make similar conclusions and also find statistically significant evidence of a gender gap at younger ages, with females outperforming males in cognition tests, but not at older ages. Although both studies use SHARE data, they use self-reported healthcare utilisation as opposed to administrative health records, which could account for this difference.

5.1 Study limitations

These results should be interpreted with several important caveats. Firstly, our observational design precludes causal inference, limiting our ability to determine whether cognitive decline directly drives increased healthcare utilisation or whether both are manifestations of underlying health deterioration. Survivorship bias may skew estimates, particularly if individuals with poorer cognitive function and worse health exit the sample earlier for health reasons. This selective attrition could lead to underestimation of the true relationship between cognitive decline and healthcare demand, especially in longer-term follow-up periods.

Additionally, our cognitive measures only capture specific domains of cognitive function, and may not reflect the full spectrum of cognitive abilities relevant to health management and healthcare-seeking behaviour. The observational nature of our data also means we cannot fully account for unmeasured variables, such as health literacy, social support networks, or individual preferences for medical care that can influence both cognitive performance and healthcare utilisation patterns. Adults in the 50+ age group are also invited for optional health screenings, such as for breast cancer and bowel cancer, which could account for healthcare contacts unrelated to cognitive status or acute health needs.

Lastly, the measure of pre-existing conditions captures medically diagnosed chronic conditions, which by definition require regular healthcare contact. Additionally, we cannot separately identify whether individuals have pre-existing cognitive diagnoses, which could attenuate our estimated relationships. These limitations should be addressed in future research by examining interactions between cognitive measures and specific pre-existing conditions, and by excluding individuals with diagnosed cognitive conditions.

5.2 Clinical and policy implications

Despite these limitations, our findings emphasise the significant role that cognitive function plays in healthcare utilisation patterns, with particularly pronounced effects for males. This sex-specific pattern suggests that cognitive screening and monitoring may be especially valuable in male populations as a predictor of future healthcare needs. The robust association for males implies that cognitive assessment could serve as an early warning system, allowing healthcare systems to anticipate and prepare for increased service demand.

These insights also highlight the necessity of developing tailored healthcare planning approaches that account for the differential impact of cognitive decline across demographic groups. Males with cognitive impairment may require more proactive primary care engagement, enhanced care coordination, and targeted resource allocation to effectively manage increasingly complex health needs. Healthcare systems should consider implementing cognitive screening protocols to identify those at risk of intensive healthcare utilisation.

Furthermore, the differential patterns observed between males and females suggest that one-size-fits-all approaches to cognitive health and healthcare planning may be insufficient. Females may benefit from different intervention strategies or monitoring approaches, though our findings suggest more research is needed to understand these relationships fully.

5.3 Opportunities for future research

The methodological challenges identified, particularly the theoretical ambiguity regarding whether cognitive decline increases healthcare demand or reduces healthcare-seeking awareness, underscore the need for future research that employs causal identification strategies.

Future work should investigate the mechanisms underlying the observed sex differences in the relationships between cognitive function and health care utilisation. Research exploring whether biological factors (such as hormonal differences), behavioural factors (such as healthcare-seeking propensity), or social factors (such as caregiver availability) drive these disparate patterns, and whether they could inform more targeted interventions. For instance, smoking history and alcohol consumption, both known risk factors of dementia (Livingston et al., 2020), could mediate or moderate the relationship between cognitive function and healthcare use. These variables are particularly important given their differential prevalence across sexes, and their potential to explain some of the sex-specific patterns we observe.

In conclusion, this study advances our understanding of how cognitive function shapes healthcare utilisation patterns in Denmark, revealing important sex-specific differences that have implications for both clinical practice and health system sustainability. While cognitive function appears to play an important role in healthcare demand, particularly for males, the complexity of these relationships and the methodological challenges involved in studying them demand continued investigation and careful consideration in developing policies for ageing populations.

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7 Appendix

Table 8: Two-part model for Females

Panel A: GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.116	0.228	0.612	0.011	0.004	0.006
Age	-0.072	0.058	0.216	0.028	0.002	<0.001
Medium education	0.277	0.826	0.737	0.631	0.098	<0.001
Low education	-0.146	1.003	0.884	0.592	0.092	<0.001
Not married	-0.223	0.731	0.760	0.200	0.029	<0.001
Pre-existing cond.	-1.742	0.867	0.045	0.102	0.014	<0.001
Not working	-0.116	0.742	0.876	-0.026	0.019	0.168
Grip strength	0.614	0.435	0.159	-0.020	0.011	0.069
Time to Interview	-1.104	0.525	0.035	0.411	0.007	<0.001
Random effects		Variance			Variance	
Individual-level		4.788			0.456	
Correlation between random effects: -0.777						
Panel A: GP Costs	Part 1: Probability of any costs			Part 2: Amount if positive costs		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.009	0.231	0.968	-0.004	0.014	0.809
Age	-0.070	0.061	0.253	0.027	0.005	<0.001
Medium education	0.604	0.880	0.492	0.420	0.105	<0.001
Low education	0.098	1.092	0.928	0.351	0.111	0.002
Not married	0.036	0.802	0.964	0.105	0.071	0.141
Pre-existing cond.	-2.044	0.949	0.031	0.218	0.046	<0.001
Not working	-0.082	0.788	0.917	-0.025	0.058	0.664
Grip strength	0.577	0.472	0.221	-0.068	0.035	0.050
Time to Interview	-1.076	0.536	0.045	0.429	0.024	<0.001
Random effects		Variance			Variance	
Individual-level		5.623			0.419	
Correlation between random effects: -0.710						

Note: $n = 283$ individuals with 1,415 observations. Balanced panel with waves 1-6

Table 9: Two-part model for - Males

Panel A: GP Visits	Part 1: Probability of any visits			Part 2: Number of visits if any		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.133	0.132	0.314	-0.023	0.005	<0.001
Age	-0.119	0.042	0.004	0.032	0.002	<0.001
Medium education	-0.691	0.521	0.185	0.054	0.097	0.578
Low education	0.346	0.604	0.567	-0.041	0.100	0.682
Not married	0.446	0.462	0.335	-0.118	0.040	0.003
Pre-existing cond.	-0.816	0.519	0.116	0.128	0.016	<0.001
Not working	0.177	0.492	0.720	0.084	0.021	<0.001
Grip strength	0.396	0.276	0.151	-0.031	0.014	0.026
Time to Interview	-1.315	0.380	<0.001	0.426	0.008	<0.001
Random effects		Variance			Variance	
Individual-level		2.687			0.527	
Correlation between random effects: -0.843						
Panel B: GP Costs	**Part 1: Probability of any costs**			**Part 2: Amount if positive costs**		
	Estimate	SE	p-value	Estimate	SE	p-value
Fixed effects						
Immediate word recall	0.154	0.136	0.259	-0.036	0.016	0.025
Age	-0.134	0.045	0.003	0.028	0.005	<0.001
Medium education	-0.906	0.573	0.113	0.177	0.111	0.111
Low education	0.137	0.640	0.830	0.178	0.129	0.169
Not married	0.268	0.516	0.603	-0.075	0.086	0.386
Pre-existing cond.	-0.909	0.535	0.090	0.284	0.052	<0.001
Not working	0.184	0.510	0.718	0.132	0.064	0.039
Grip strength	0.332	0.292	0.254	-0.042	0.042	0.323
Time to Interview	-1.390	0.397	<0.001	0.442	0.028	<0.001
Random effects		Variance			Variance	
Individual-level		3.567			0.507	
Correlation between random effects: -0.910						

Note: $n = 256$ individuals with 1,280 observations. Balanced panel with waves 1-6