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Educational disparities in dementia incidence and healthcare utilization: evidence from a cohort study in Italy

Agostino Cristofalo [a,*], Silvia Cascini [b], Giulia Cesaroni [b], Eleonora Trappolini [c], Nera Agabiti [b], Anna Maria Bargagli [b]

[a] *Department of Statistical Sciences, Sapienza University of Rome, Piazzale Aldo Moro, 5, 00185, Rome, Italy*
[b] *Department of Epidemiology of Lazio Region Health Service, ASL Roma 1, Via Cristoforo Colombo, 112, 00147, Rome, Italy*
[c] *Department of Methods and Models for Economics, Territory and Finance, Sapienza University of Rome, Via del Castro Laurenziano, 9, 00161, Rome, Italy*

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ABSTRACT

While educational disparities in dementia incidence are well-known, whether and to what extent they persist beyond dementia onset is less explored. In this study, we investigated educational disparities in the risk of dementia diagnosis in administrative health records (dementia incidence) and subsequent healthcare utilization among dementia patients. We analysed the Lazio Region Longitudinal Study (Italy) from 2012 to 2022. We applied Cox regression to investigate disparities in dementia incidence and three subsequent healthcare utilization outcomes (all-cause hospitalizations, potentially preventable hospitalizations, and emergency visits). In a cohort of dementia-free 50–90-year-olds (907 453 men and 1 083 538 women), we found strong and age-patterned disparities in dementia incidence. Compared to highly-educated, the incidence in low-educated men and women was higher, especially at ages 50–64 (HR = 2.09, 95 % CI: 1.69–2.58 and HR = 2.17; 95 % CI: 1.71–2.74). In the follow-up of 27 158 men and 40 797 women incident dementia cases, low-educated had higher risk of all-cause hospitalizations (HR = 1.24; 95 % CI: 1.16–1.32 and HR = 1.18; 95 % CI: 1.09–1.27), potentially-preventable hospitalizations (HR = 1.27; 95 % CI: 1.17–1.37 and HR = 1.19; 95 % CI: 1.08–1.31) and emergency visits (HR = 1.33; 95 % CI: 1.26–1.41 and HR = 1.27; 95 % CI: 1.18–1.35). Disparities in hospitalization are reduced after adjusting for health conditions pre-existing dementia identification, less so those in emergency visits. Overall, disparities in dementia incidence persisted to a lesser extent in subsequent healthcare utilization and were mostly accounted by pre-existing health conditions.

1. Introduction

Dementia is a major public health concern that poses unprecedented challenges for individuals, families, and societies. Rising global life expectancy will lead to a massive increase in dementia cases in the near future, from around 50 million in 2020 to 152 million in 2050, with the greatest increase expected in low- and middle-income countries (Livingston et al., 2020). The burden of dementia is sizeable, as the condition is often accompanied by disability and multimorbidity (Beltz et al., 2022; Grande et al., 2021) and demands high levels of care from both healthcare systems and informal caregivers. Dementia is also very expensive. The global cost of dementia was estimated to be around 262 billion U.S. dollars in 2019 and is increasing in all regions of the world (Pedroza et al., 2022). Although the short-run rise of dementia is inevitable, public health initiatives aimed at eliminating modifiable risk factors could significantly reduce the burden and the costs of dementia in ageing societies in the long run (Livingston et al., 2020; Mayer et al., 2018).

A modifiable risk factor for dementia and a key dimension of socioeconomic disparities in health is low education (Crimmins et al., 2018; Maccora et al., 2020; Meng and D'Arcy, 2012; Sharp and Gatz, 2011; Xu et al., 2016). Low education is responsible for 5–9 % of global dementia prevalence (Livingston et al., 2024; Stephan et al., 2024) and around 1.7 million dementia cases in Europe (Mayer et al., 2018). Several explanations justify the association between the level of education and dementia incidence. First, the cognitive reserve hypothesis suggests that greater cognitive stimulation experienced by highly-educated delays the clinical manifestation of cognitive decline in

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* Corresponding author.
E-mail address: agostino.cristofalo@uniroma1.it (A. Cristofalo).

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the face of incipient brain deterioration (Meng and D'Arcy, 2012; Stern, 2002). Second, low-educated individuals are more likely to adopt lifestyles and behaviours associated with increased dementia risk, such as smoking, alcohol consumption, and physical inactivity (Huisman et al., 2005; Livingston et al., 2020; Shaw and Spokane, 2008; Tschorn et al., 2023). Third, low-educated individuals face more chronic stress due to insecure living circumstances, social isolation, and discrimination, resulting in potentially increased dementia risk (Bodryzlova et al., 2022; Bougea et al., 2022).

Previous research has consistently reported educational disparities in dementia incidence in Italy (De Ronchi et al., 2005; Di Carlo et al., 2002; Noale et al., 2013) and elsewhere (Bodryzlova et al., 2022; Maccora et al., 2020; Meng and D'Arcy, 2012; Xu et al., 2016). Shifts in the educational composition of the population can therefore be effective in reducing dementia risk, as recently witnessed in some high-income contexts (Langa, 2015; Mayer et al., 2018).

While much attention has been given to disparities in dementia incidence, whether and to what extent such disparities persist beyond dementia onset remains less explored. To address this question, this study examined educational disparities in subsequent healthcare utilization among individuals with incident dementia. Dementia patients constitute a vulnerable group within the elderly population, with disproportionately high use of healthcare services, including all-cause hospitalizations, potentially preventable hospitalizations, and emergency department visits (Bynum et al., 2004; LaMantia et al., 2016; Motzek et al., 2018; Sommerlad et al., 2019). Exploring disparities in subsequent healthcare utilization offers deeper insights into the burden of disease throughout dementia patients' life courses and sheds light on potential inequities beyond dementia that require attention.

To investigate disparities in subsequent healthcare utilization, we draw on Andersen's Behavioural Model (Andersen, 1968, 1995). This model conceptualizes healthcare use as a function of predisposing and enabling factors that influence individuals' need of care. Within this framework, education is a predisposing factor that plays a two-fold role. It influences both the 'biological' need of care, by determining health conditions, disease severity, and progression (Andersen, 1995; Yue et al., 2021) and the 'evaluated' need of care, that encompasses factors such as health literacy, ability and resources to cope with health issues autonomously, the quantity and quality of caregiver support, and the perceived structural barriers to accessing healthcare (Andersen, 1995; Trappolini et al., 2020). This is particularly relevant in the Italian context, where advanced population ageing and public spending constraints threaten the sustainability and ability of the National Health System to provide equitable healthcare services (Ricciardi and Tarricone, 2021).

Exploring both dementia incidence and subsequent healthcare utilization disparities is informative in several respects. Indeed, disparities reflect differences in the risk of developing the condition, but also in the ways patients and support networks manage it, with lower-educated individuals potentially facing a double disadvantage if showing a higher dementia risk and reduced ability to cope with its consequences. Recent studies have shown that socioeconomic deprivation is associated with a higher risk of elective and emergency hospitalization for individuals living with dementia (Sommerlad et al., 2019).

Dementia incidence and healthcare utilization among dementia patients also have some sex-specific patterns. Women generally have higher dementia prevalence and incidence than men (Ponjoan et al., 2019), and some studies reported sex-based differences in the relationship between level of education and dementia risk (Letenneur et al., 2000; Noale et al., 2013). Concerning healthcare utilization, women with dementia were shown to use more ambulatory and pharmaceutical care compared to men, who instead use acute hospital care more extensively (Arsenault-Lapierre et al., 2024).

Given these considerations, we pursued two main objectives. First, we investigated educational disparities in dementia incidence, approximated by dementia identification in administrative health records. Second, we investigated whether and to what extent educational disparities persisted in subsequent healthcare utilization among dementia incident cases, examining the subsequent risk of experiencing three outcomes separately: all-cause hospitalizations, potentially preventable hospitalizations, and emergency department visits.

This study makes several contributions to existing research. To the best of our knowledge, it is one of the few studies, and the first one in the Italian context, to explore educational disparities in dementia incidence using data from a large population-based cohort and administrative health records. Additionally, it explores the age-patterning of educational disparities in dementia incidence, providing insights into when they are most pronounced across the life course. Lastly, by analysing subsequent healthcare utilization among individuals with incident dementia, this study highlights how education influences the burden of dementia beyond its onset and throughout the remainder of the life course.

2. Methods

2.1. Setting

The study was conducted in Lazio, the second-largest region in Italy, which includes Rome, from 2012 to 2022. Lazio is characterized by high life expectancy and advanced population ageing (ISTAT, 2022). In Italy, hospital and emergency care are universally provided free of charge by the National Health Service, which is organized on a regional basis. The main pharmaceutical treatments for dementia – i.e., galantamine, rivastigmine, donepezil, and memantine – are available free of charge on prescription.

2.2. Data

We used the Lazio Region Longitudinal Study, which combines data from the 2011 Italian Population and Households Census, including all residents in Lazio at the time of the census, with health records from regional administrative databases. The datasets are linked by dedicated authorised personnel through a personal identification number assigned by the *Agenzia delle Entrate* (Italian Revenue Agency). We leveraged health records from several registries. The Patient Registry contains the list of all residents registered within the Regional Health Service. The Hospital Discharge Registry collects records of hospital discharges from all public hospitals within the region, with diagnoses coded under the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). The Drug Claims Registry contains records of all drug prescriptions reimbursed by the Regional Health Service, dispensed to individuals, coded according to the Anatomical Therapeutic Chemical (ATC) classification. The Ticket Exemption Registry collects records of exemptions from healthcare co-payments, coded according to the National Exemption Codification System. Disease-specific exemptions from healthcare co-payment are granted solely based on medical criteria following a formal diagnosis and are a standard practice in Italy's universal healthcare system, regardless of patients' socioeconomic conditions. The Emergency Department Registry collects records of emergency visits. The Mortality Registry provides information on the date and cause of death.

2.3. Research design and study population

We carried out a cohort study. We first analysed dementia-free Lazio residents aged 50–90 on January 1, 2012, included in the Lazio Region Longitudinal Study. To ascertain whether individuals were dementia-free, we employed a validated algorithm with a look-back period of five years from baseline (Bacigalupo et al., 2022). We followed dementia-free individuals from January 1, 2012 until dementia identification (index date), right-censoring, or the end of follow-up on 31[st] December 2022. Individuals were right-censored if they were no longer registered within the regional Health Service or died. Afterwards, we analysed incident dementia cases and followed them from the index date until the first occurrence of the following outcomes separately: all-cause hospitalizations, potentially preventable hospitalizations, and emergency visits. Right-censoring and end of follow-up were applied as before.

2.4. Outcomes

Our primary outcome is dementia incidence, which we operationalized as the risk of identification of several forms of dementia, including Alzheimer's disease, vascular dementia, frontotemporal dementia, Lewy bodies dementia, and other types, using administrative health records (see Table S1, available in Supplementary Materials). To identify dementia cases, we employed an algorithm that considers individuals who meet at least one of the following conditions: a) they have at least two different prescriptions of drugs for dementia within twelve months, as retrieved from the Drug Claims Registry; b) they have at least one hospital discharge with a primary or secondary diagnosis of dementia, as retrieved from the Hospital Discharge Registry; c) they report at least one exemption from healthcare co-payment specific to dementia, as retrieved from the Ticket Exemption Registry (Bacigalupo et al., 2022) (Supplementary Table S1, available in Supplementary Materials). The index date is the earliest occurrence of the three conditions.

In the follow-up of incident cases, we separately investigated the risk of all-cause hospitalizations, potentially preventable hospitalizations, and emergency visits. Information on hospitalizations and emergency visits were retrieved from the Hospital Discharge Registry and the Emergency Department Registry. In line with other studies (Anderson et al., 2020; McCarthy et al., 2020), we conceptualized potentially preventable hospitalizations as those determined by ambulatory care sensitive conditions (ACSCs), i.e., conditions for which medical experts consider hospitalization avoidable with appropriate ambulatory care (Billings et al., 1993) and bone fractures. We considered the following diagnoses as ACSCs: pneumonia, sepsis, dehydration, urinary tract infection, asthma, chronic obstructive pulmonary disease (COPD), heart failure (Supplementary Table S2, available in Supplementary Materials).

2.5. Exposure and control variables

The exposure variable was the level of education obtained at baseline from the Census. The variable was categorized into three levels: low (up to lower-secondary education), middle (from upper-secondary to post-secondary non-tertiary education), and high (tertiary education).

To analyse disparities in dementia incidence, we adjusted for potential confounders such as place of residence, retrieved from the Census and categorized as Rome, other municipalities in Rome province, and other municipalities in Lazio, and place of birth, obtained from the Census and categorized as in the municipality of residence, in another Italian municipality, and abroad. When examining healthcare utilization, in order to account for the heterogeneity of health conditions at index date, we additionally adjusted for a wide range of comorbidities identified from hospital discharge diagnoses up to twenty-four months prior to the index date – i.e., diabetes, COPD, pneumonia, neoplasms, electrolytes and base-acid balance disorders, chronic kidney diseases, Parkinson's disease, disease of the blood and blood-forming organs, chronic liver, pancreas, and intestine disease, fracture of neck femur – and pharmaceutical treatments dispensed up to twelve months prior to index date – i.e., cardiac therapy, antihypertensives, lipid modifying agents, antiplatelets, proton pump inhibitors, insulins and analogues, blood glucose-lowering drugs (excluding insulins), psychoanaleptics (excluding anti-dementia), antipsychotics, antiepileptics, antithrombotic agents, antibacterials for systemic use, endocrine therapy, analgesics, anticholinergics (Supplementary Table S3, available in Supplementary Materials).

2.6. Statistical analysis

All the analyses were conducted separately by sex. We summarized variables with absolute and relative frequencies. We further provided the number of dementia cases, person-years at risk, crude incidence rate with 95 % confidence intervals (95 % CI), and prevalence at baseline. We cross-tabulated healthcare utilization outcomes and covariates by the level of education, reporting absolute frequencies and column percentages.

We used Cox proportional hazards regression models to estimate risk differentials by level of education in dementia incidence and in subsequent healthcare utilization. We expressed the results as hazard ratios (HRs) with 95 % confidence intervals (95 % C.I). To account for left-truncation and simultaneously adjust for age-dependence (Korn et al., 1997), we used continuous age as timescale and stratified baseline hazards by five-year birth cohorts. For each outcome, we evaluated the assumption of proportional hazards using the Schoenfeld residuals test. As proportionality was not satisfied for dementia incidence, we split the time axis into three age segments – 50–64, 65–89, 90 and over – and estimated HRs separately in each segment. We fitted two different models: one with the exposure variable only and one adjusting for place of residence and place of birth. For healthcare utilization, we fitted a third model additionally adjusting for comorbidities and pharmaceutical treatments. As a sensitivity check, we replicated the analyses using death as a competing risk to dementia incidence and each of the healthcare utilization outcomes.

3. Results

3.1. Dementia incidence

We studied 907 453 men and 1 083 538 women who were ascertained as dementia-free at baseline, with a mean age of 65.5 ± 10.2 and 66.7 ± 10.8 respectively. Compared to dementia-free women, men had a higher proportion of individuals with middle (29.6 % vs 25.8 %) and higher education (14.3 % vs 10.4 %). The distribution of place of residence was similar for both sexes, but a higher proportion of women were foreign-born than men (5.3 % vs 3.5 %). Throughout the follow-up, 27 158 men and 40 797 women developed dementia, with a slightly higher crude incidence rate for women than men (3.96 vs 3.23 events per 1000 person-years). Across sexes, a higher crude incidence rate was found among the low-educated, residents in other provinces in Lazio, and native-born individuals (Table 1).

In exposure-only regression models, low- and middle-educated men had a higher incidence of dementia than highly-educated in each age segment. After adjusting for confounders, we observed limited changes in HRs, particularly among low-educated individuals. Compared to the highly-educated men, low-educated men displayed the largest hazard ratio for dementia incidence at ages 50–64 (HR = 2.09; 95 % CI: 1.69–2.58), which then attenuated at ages 65–89 (HR = 1.42; 95 % CI: 1.36–1.49), and reinforced slightly at age 90 and over (HR = 1.54; 95 % CI: 1.36–1.74). Middle-educated men had intermediate risk, with HR = 1.33 (95 % CI: 1.06–1.66) at ages 50–64, HR = 1.15 (95 % CI: 1.09–1.21) at ages 65–89, and HR = 1.30 (95 % CI: 1.12–1.51) at age 90 and over (Fig. 1, Supplementary Tables S4, S5, S6, and S7 available in Supplementary Materials).

A similar gradient and age-patterning was observed among women. In the fully adjusted model, dementia incidence for low-educated women was 2.17 times higher (95 % CI: 1.71–2.74) than highly-educated at ages 50–64, 1.45 times higher (95 % CI: 1.38–1.54) at ages 65–89, and 1.36 times higher (95 % CI: 1.21–1.54) at age 90 and over. The respective HRs for middle-educated were 1.40 (95 % CI: 1.09–1.79), 1.12 (95 % CI: 1.05–1.19), and 1.01 (95 % CI: 0.88–1.16). While disparities among men reduced after age 65 and increased slightly after age 90, the decline in disparities over age was more pronounced among women (Fig. 1).

Table 1
Descriptive statistics of 50–90 year-old dementia-free population by sex (2012–2022).

Variables	N (%)	Prevalence at baseline * thousand	Events	PY	Crude incidence rate * thousand PY (95 % CI)
Men	**907 453 (100)**	**9.4**	**27 158**	**8 401 129**	**3.23 (3.19–3.27)**
Age at baseline					
50–54	172 588 (19.0)	0.3	349	1 782 945	0.20 (0.18–0.22)
55–59	153 331 (16.9)	0.9	716	1 572 526	0.46 (0.42–0.49)
60–64	151 406 (16.7)	2.1	1501	1 511 928	0.99 (0.94–1.04)
65–69	125 435 (13.8)	4.4	2845	1 204 955	2.36 (2.28–2.45)
70–74	120 711 (13.3)	10.0	5475	1 084 691	5.05 (4.91–5.18)
75–79	90 743 (10.0)	24.0	7141	713 498	10.01 (9.78–10.24)
80–84	60 823 (6.7)	38.6	6035	383 178	15.75 (15.36–16.15)
85–90	32 416 (3.6)	49.8	3096	147 408	21 (20.27–21.75)
Level of education					
Low	509 330 (56.1)	12.5	19 912	4 534 512	4.39 (4.33–4.45)
Middle	268 800 (29.6)	5.0	4677	2 624 043	1.78 (1.73–1.83)
High	129 323 (14.3)	6.3	2569	1 242 574	2.07 (1.99–2.15)
Residence					
Rome (municipality)	428 984 (47.3)	10.8	14 039	3 967 300	2.91 (2.84–2.99)
Rome (other municipalities in the province)	213 863 (23.6)	8.4	5780	1 983 214	2.99 (2.93–3.06)
Other provinces in Lazio	264 606 (29.2)	8.0	7339	2 450 615	3.54 (3.48–3.60)
Place of birth					
In the municipality of residence	423 918 (46.7)	8.2	11 640	3 986 847	2.92 (2.87)
In another Italian municipality	452 216 (49.8)	10.8	14 953	4 130 278	3.56 (3.56–3.68)
Abroad	31 319 (3.5)	5.8	565	284 004	1.99 (1.83–2.16)
Women	**1 083 538 (100)**	**14.0**	**40 797**	**10 306 135**	**3.96 (3.92–4.00)**
Age at baseline					
55–59	168 018 (15.5)	0.8	578	1 759 400	0.33 (0.30–0.36)
60–64	167 169 (15.4)	1.7	1394	1 725 681	0.81 (0.77–0.85)
65–69	143 435 (13.2)	4.4	3119	1 448 848	2.15 (2.08–2.23)
70–74	144 188 (13.3)	11.3	6880	1 387 928	4.96 (4.84–5.08)
75–79	117 793 (10.9)	27.8	10 539	1 020 141	10.33 (10.13–53)
80–84	91 592 (8.5)	50.2	10 909	653 094	16.7 (16.29–17.02)
85–90	63 168 (5.8)	65.1	7058	332 142	21.25 (20.76–21.75)
Level of education					
Low	691 986 (63.9)	18.5	33 866	6 383 257	5.31 (5.25–5.36)
Middle	279 295 (25.8)	6.2	5204	2 793 273	1.86 (1.81–1.91)
High	112 257 (10.4)	4.9	1727	1 129 605	1.53 (1.46–1.60)
Residence					
Rome (municipality)	544 369 (50.2)	15.0	22 113	5 170 202	3.55 (3.47–3.63)
Rome (other municipalities in the province)	241 120 (22.3)	12.6	8171	2 302 125	3.71 (3.64–3.78)
Other municipalities in Lazio	298 049 (27.5)	13.3	10 513	2 833 808	4.28 (4.22–4.33)
Place of birth					
In the municipality of residence	465 100 (42.9)	12.2	16 236	4 482 817	3.62 (3.57–3.68)
In another Italian municipality	560 983 (51.8)	16.1	23 496	5 288 625	4.44 (4.39–4.50)
Abroad	57 455 (5.3)	6.7	1065	534 693	1.99 (1.87–2.11)

3.2. Healthcare utilization among dementia patients

We started from 27 158 men and 40 797 women dementia incident cases. A total of 3663 men and 4432 women were excluded, either due to death (3478 men and 4105 women) or leaving the Patient Registry on the index date (185 men and 327 women). Among the remaining 23 495 men and 36 365 women, 12 283 (52.3 %) men and 17 139 (47.1 %) women experienced all-cause hospitalizations; 7923 (33.7 %) men and 11 694 (32.2 %) women experienced potentially preventable hospitalizations; and 15 807 (67.3 %) men and 23 605 (64 %) women visited emergency departments.

Cross-tabulations showed negligible educational differences in the percentage of all-cause hospitalizations, potentially preventable hospitalizations, and emergency visits (Table 2). However, greater differences emerged for other covariates, such as place of residence, comorbidities (e.g., diabetes, COPD and Parkinson's disease among men, disease of the blood and blood-forming organs, chronic liver, pancreas, and intestine disease), as well as pharmaceutical treatments for cardiometabolic and psychiatric disorders (Table 2).

Regarding all-cause hospitalizations, exposure-only regression models showed moderate risk differentials for men and women, with minimal changes in HRs after adjusting for place of birth and residence. In the second model (Fig. 2), the risk of hospitalization was 1.24 times higher for low-educated men (95 % CI: 1.16–1.32) and 1.12 for middle-educated men (95 % CI: 1.04–1.20) compared to highly-educated peers. Among women, the risk was 1.18 times higher for the low-educated (95 % CI: 1.09–1.27) and only 1.07 for middle-educated (95 % CI: 0.99–1.17). In fully adjusted models, small and poorly significant disparities were observed, with the risk only about 5 % higher for low- and

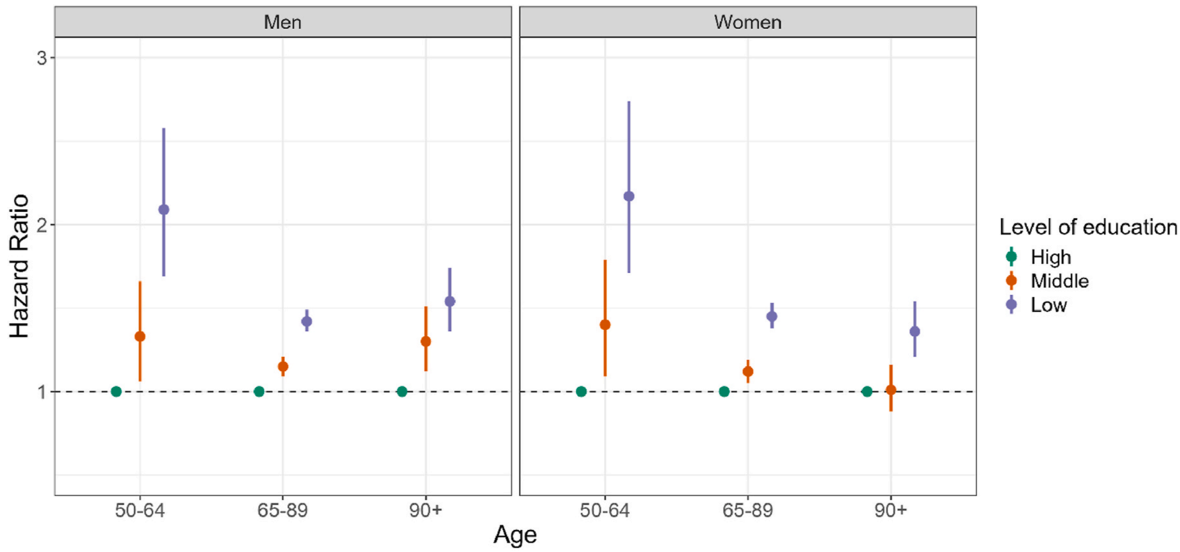

Fig. 1. Hazard ratios with 95 % confidence intervals from Cox regression on the risk of dementia by sex and level of education (2012–2022).
Note: Models adjusted for residence and place of birth. Continuous age as timescale.

middle-educated men and women than highly-educated.

Similar results were found for potentially preventable hospitalizations. In the second model, among men, the risk for low-educated was 1.27 times higher (95 % CI: 1.17–1-37) than for highly-educated and 1.14 (95 % CI: 1.04–1.25) for middle-educated. Among women, the risk was 1.19 times higher (95 % CI: 1.08–1.31) for low-educated and 1.12 (95 % CI: 1.01–1.25) for middle-educated. In fully adjusted models, these disparities were reduced to around 5 % for both low- and middle-educated individuals of both sexes.

Concerning emergency visits, we observed larger and differently patterned educational gradients for men and women. In the second model, the risks for low- and middle-educated men were, respectively, 1.33 (95 % CI: 1.26–1.41) and 1.22 (95 % CI: 1.14–1.30) times higher than highly-educated. Among women, we observed a similarly elevated risk for the low-educated (HR = 1.31; 95 % CI: 1.22–1.40), while the risk for middle-educated was comparable to that of the highly-educated (HR = 1.05; 95 % CI: 0.98–1.14). Disparities decreased when we additionally adjusted for comorbidities and pharmaceutical treatments but remained sizeable. For men, the HR shrank to 1.24 (95 % CI: 1.17–1.31) for low-educated, and to 1.19 (95 % CI: 1.11–1.26) for middle-educated. For women, the respective HRs were 1.17 (95 % CI: 1.10–1.26) and 1.04 (95 % CI: 0.97–1.12).

4. Discussion

We found compelling evidence of large and age-patterned educational disparities in dementia incidence among 50-90-year-old residents in Lazio, Italy. The risk was particularly high for low-educated individuals at younger ages (50–64), for both sexes, decreased at intermediate ages (65–89), and slightly diverged across sexes at older ages (90 and over). We also observed moderate but still significant educational disparities in healthcare utilization among incident dementia cases. Disparities were similar for all-cause and potentially preventable hospitalizations, with both diminishing after adjusting for comorbidities and pharmaceutical treatments. Conversely, disparities in emergency visits were larger and persisted more, even after adjustment for comorbidities and pharmaceutical treatments, similarly for both sexes.

Our findings on dementia incidence are consistent with several previous prospective cohort studies showing educational disparities in different contexts (Maccora et al., 2020; Xu et al., 2016). Our results on incidence rates also align with recent studies using population-linked health records in Sweden, Denmark, and the UK (Appel et al., 2022; Chung et al., 2023; Seblova et al., 2018). The larger educational disparities observed in early-onset dementia are also in line with findings from a recent UK study using health records (Li et al., 2023).

We explored the age-patterning of these disparities, which revealed slightly different patterns by sex. As previously discussed, the observed educational disparities may be driven by differences in the levels of cognitive reserve, lifestyles, preventive behaviours, or uneven exposure to chronic stress, discrimination, and social isolation (Maccora et al., 2020). Larger disparities at younger ages, followed by reductions at older ages, could reflect the increasing generalized risk of developing dementia in old age, combined with selective mortality among low-educated individuals. However, for men, disparities slightly increased at very old ages.

Our results on educational disparities in subsequent healthcare utilization among dementia patients are consistent with studies showing a higher risk of hospitalizations and emergency visits among socioeconomically deprived individuals (Sommerlad et al., 2019; Williamson et al., 2021). To our knowledge, none of these previous studies used educational level as an indicator of socioeconomic position. We compared disparities across several healthcare utilization outcomes, revealing sex differences and outcome differences after adjusting for pre-existing health conditions. Our findings on all-cause and potentially preventable hospitalizations align with previous studies on the general population, showing that educational disparities attenuate significantly after adjusting for health conditions (Yue et al., 2021). However, unlike some studies that report a reversal of disparities (Agerholm et al., 2013; Kristenson et al., 2011; van Doorslaer, 2006), we did not observe such a shift. Notably, disparities in emergency department visits showed a different pattern, with initial disparities attenuated to a much lesser extent. This suggests that, even when we compared individuals with the same pre-existing health conditions, low-educated individuals with dementia were still significantly more likely to visit emergency departments. This pattern likely reflects a combination of greater dementia-related health needs, lower health literacy, and differences in the ability of patients, caregivers, and support networks to manage health conditions effectively.

In the context of population aging, reducing educational gaps in dementia incidence is essential for mitigating the overall disease burden and promoting cognitive health for all. Since most educational disparities in dementia manifest as differences in the risk of developing the condition itself (i.e., dementia incidence), our results urge greater efforts from public health authorities to prioritize prevention strategies,

Table 2
Cross-tabulation by sex and level of education of incident dementia cases (2012–2022).

Variables	Men				Women			
	Low	Middle	High	Overall	Low	Middle	High	Overall
All-cause hospitalization	9076 (52.9)	2069 (50.6)	1138 (50.9)	12 283 (52.3)	14 374 (47.7)	2085 (44.4)	680 (43.6)	17 139 (47.1)
Potentially preventable hospitalization	5883 (34.3)	1315 (32.1)	725 (32.4)	7923 (33.7)	9796 (32.5)	1444 (30.8)	454 (29.1 %)	11 694 (32.2)
Emergency visits	11 661 (67.9)	2700 (66.0)	1446 (64.6)	15 807 (67.3)	19 587 (65.0)	2795 (59.6)	901 (57.8)	23 283 (64.0)
Residence								
Rome (municipality)	7917 (46.1)	2603 (63.6)	1692 (75.6)	12 212 (52.0)	15 233 (50.6)	3401 (72.5)	1259 (80.8)	19 893 (54.7)
Rome (other municipalities in the province)	3933 (22.9)	743 (18.2)	267 (11.9)	4943 (21.0)	6433 (21.4)	647 (13.8)	127 (8.1)	7207 (19.8)
Other municipalities in Lazio	5317 (31.0)	745 (18.2)	278 (12.4)	6340 (27.0)	8447 (28.1)	645 (13.7)	173 (11.1)	9265 (25.5)
Place of birth								
In the municipality of residence	7627 (44.4)	1703 (41.6)	798 (35.7)	10 128 (43.1)	12 063 (40.1)	1899 (40.5)	540 (34.6)	14 502 (39.9)
In another Italian municipality	9318 (54.3)	2229 (54.5)	1336 (59.7)	12 883 (54.9)	17 469 (58.0)	2526 (53.8)	932 (59.8)	20 927 (57.5)
Abroad	222 (1.3)	159 (3.9)	482 (2.1)	484 (2.1)	581 (1.9)	268 (5.7)	87 (5.6)	936 (2.6)
Comorbidities[a]								
Diabetes	1577 (9.2)	319 (7.8)	127 (5.7)	2023 (8.6)	2049 (6.8)	188 (4.0)	60 (3.8)	2297 (6.3)
COPD	1942 (11.3)	312 (7.6)	164 (7.3)	2418 (10.3)	2074 (6.9)	275 (5.9)	76 (4.9)	2425 (6.7)
Pneumonia	1888 (11.0)	441 (10.8)	234 (10.5)	2563 (10.9)	2177 (7.2)	351 (7.5)	99 (6.4)	2627 (7.2)
Neoplasms	981 (5.7)	237 (5.8)	124 (5.5)	1342 (5.7)	861 (2.9)	152 (3.2)	48 (3.1)	1061 (2.9)
Electrolytes and base-acid balance disorders	1162 (6.8)	263 (6.4)	120 (5.4)	1545 (6.6)	2120 (7.0)	297 (6.3)	90 (5.8)	2507 (6.9)
Chronic kidney diseases	1837 (10.7)	383 (9.4)	218 (9.7)	2438 (10.4)	2062 (6.1)	229 (4.9)	64 (4.1)	2336 (6.4)
Parkinson's disease	603 (3.5)	186 (4.5)	105 (4.7)	894 (3.8)	593 (2.0)	103 (2.2)	36 (2.3)	732 (2.0)
Disease of the blood and blood-forming organs	1532 (8.9)	292 (7.1)	148 (6.6)	1961 (8.3)	2664 (8.8)	354 (7.5)	106 (6.8)	3124 (8.6)
Chronic liver, pancreas, and intestine disease	226 (1.3)	51 (1.2)	19 (0.8)	296 (1.1)	238 (0.8)	40 (0.9)	8 (0.5)	284 (0.8)
Fracture of neck femur	352 (2.1)	90 (2.2)	44 (2.0)	486 (2.1)	1058 (3.5)	163 (3.5)	47 (3.0)	1268 (3.5)
Pharmaceutical treatments[b]								
Cardiac therapy	3401 (19.8)	618 (15.1)	371 (16.6)	4390 (18.7)	5696 (18.9)	571 (12.2)	192 (12.3)	6459 (17.8)
Antihypertensives	12 424 (72.4)	2733 (66.8)	1486 (66.4)	16 643 (70.8)	22 151 (73.6)	2949 (62.8)	942 (60.4)	26 042 (71.6)
Lipid modifying agents	6049 (35.2)	1374 (33.6)	762 (34.1)	8185 (34.8)	9542 (31.7)	1325 (28.2)	413 (26.5)	11 280 (31.0)
Antiplatelets	9411 (54.8)	1821 (44.5)	911 (40.7)	12 143 (51.7)	13 891 (49.5)	1827 (38.9)	533 (34.2)	17 251 (47.4)
Proton pump inhibitors	10 404 (60.6)	2161 (528)	11 130 (50.5)	13 695 (58.3)	17 820 (59.2)	2371 (50.5)	734 (47.1)	20 925 (57.5)
Insulins and analogues	1287 (7.5)	251 (6.1)	102 (4.6)	1640 (7)	1893 (6.3)	171 (3.6)	54 (3.5)	2118 (5.8)
Blood glucose lowering drugs, excl. Insulins	3471 (20.2)	708 (17.3)	349 (15.6)	4528 (19.3)	4850 (16.1)	505 (10.8)	149 (9.6)	5504 (15.1)
Psychoanaleptics (excl. anti-dementia)	4709 (27.4)	1198 (29.3)	719 (32.1)	6626 (28.2)	11 086 (36.8)	1725 (36.8)	561 (36.0)	13 372 (36.8)
Antipsychotics	3628 (21.1)	798 (19.5)	434 (19.4)	4860 (20.7)	6359 (21.1)	987 (21.0)	328 (21.0)	7674 (21.1)
Antiepileptics	2177 (12.7)	544 (13.3)	282 (12.6)	3003 (12.8)	3427 (11.4)	562 (12.0)	177 (11.4)	4166 (11.5)
Antithrombotic agents	11 827 (68.9)	2354 (57.5)	1234 (55.2)	15 415 (65.6)	19 225 (63.8)	2421 (51.6)	726 (46.6)	22.372 (61.5)
Antibacterials for systemic use	9568 (55.7)	1952 (47.7)	1109 (49.6)	12 629 (53.8)	15 704 (52.2)	2098 (44.7)	669 (42.9)	18 471 (50.8)
Endocrine therapy	534 (3.1)	96 (2.3)	61 (2.7)	691 (2.9)	391 (1.3)	73 (1.6)	26 (1.7)	490 (1.3)
Analgesics	2543 (14.8)	503 (12.3)	262 (11.7)	3308 (14.1)	5575 (18.5)	723 (15.4)	251 (16.1)	6549 (18.0)
Anticholinergics	2420 (14.1)	702 (17.2)	423 (18.9)	3545 (15.1)	4591 (15.2)	767 (16.3)	249 (16.0)	5607 (15.4)
Total	17 167 (100)	4091 (100)	2237 (100)	23 495 (100)	33 866 (100)	4693 (100)	1559 (100)	36 365 (100)

Note: N (column %).
[a] Diagnosed from hospital discharges up to 24 months before dementia identification.
[b] Reimbursed up to 12 months before dementia identification.

especially for low-educated populations, in order to reduce such disparities. These strategies could include both modifying the educational composition of the population– e.g., by increasing the rate of university graduates – or addressing the pathways that link low education to increased dementia risk, such as improving health literacy, promoting anti-smoking and healthy behaviours campaigns. At the same time, efforts should also focus on minimizing the lower but still present educational disparities in subsequent healthcare utilization among dementia patients. This could be achieved, for example, by improving care pathways for patients and caregivers and ensuring equitable access to home care and/or long-term care facilities.

4.1. *Strengths and limitations*

Our study has several strengths. We leveraged comprehensive, up-to-date health records linked to the population Census, which provided high statistical power and detailed health information, minimizing biases typically associated with self- or proxy-reported dementia. Dementia cases were identified using a validated algorithm with good sensitivity and specificity (Bacigalupo et al., 2022). Using educational level as the main exposure variable was particularly suitable for approximating both socioeconomic position and level of cognitive reserve. Moreover, education stabilizes in young adulthood (Galobardes et al., 2007), addressing the potential limitation of using a time-constant

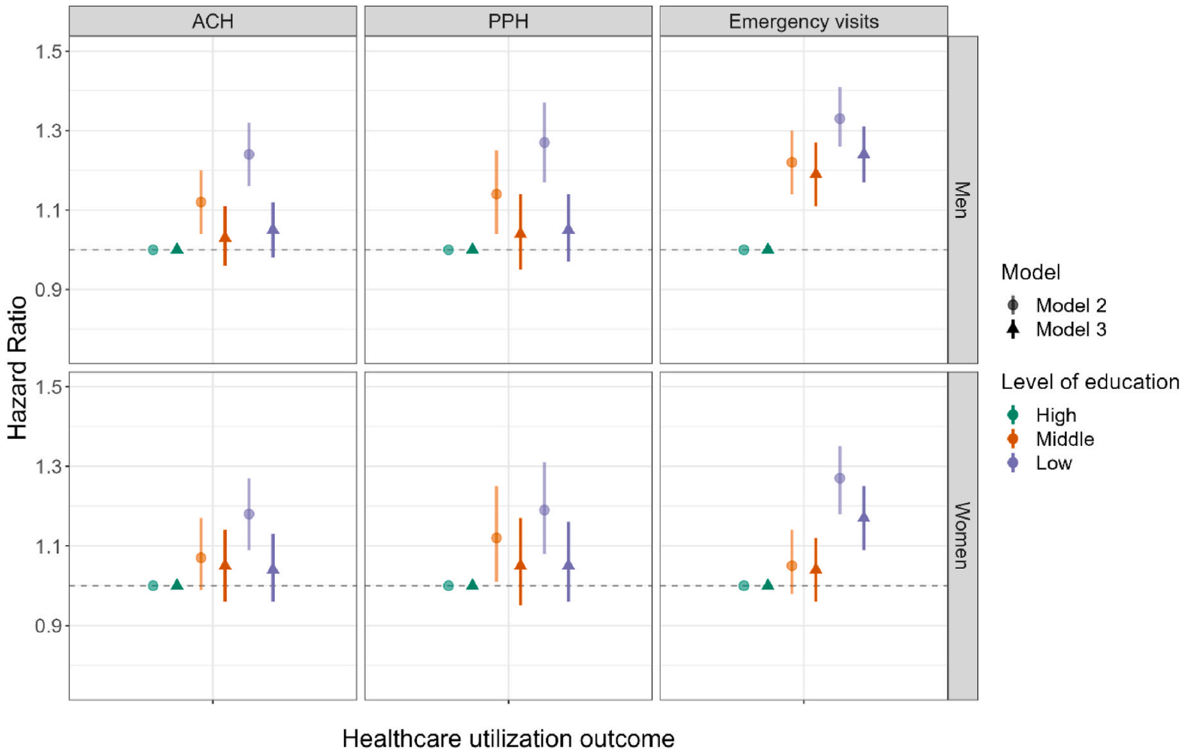

Fig. 2. Hazard ratios with 95 % confidence intervals from Cox regression on all cause hospitalizations (ACH), potentially preventable hospitalizations (PPH), and emergency visits, by sex and level of education (2012–2022).
Note: Model 2 is adjusted for residence and place of birth. Model 3 is additionally adjusted for comorbidities and pharmaceutical treatment. ACH = all-cause hospitalization. PPH= Potentially preventable hospitalization.

exposure measured at baseline. Our study context—characterized by exceptionally advanced population ageing—can serve as a valuable benchmark for countries that will experience similar demographic shifts and a rise in dementia due to population aging in the near future. Lastly, our results remained robust to sensitivity analyses that accounted for death as a competing risk for each outcome, with findings virtually unchanged.

However, our study also comes with limitations. First, we used dementia identification as a proxy for dementia incidence, acknowledging that this approximation may not always be precise. Health records are inherently conditioned by patients' interaction with the Regional Health Service, particularly in hospital care, drug reimbursement, and copayment exemptions in Lazio Region. As a result, a few individuals in the cohort were identified with dementia on the same day they died, which likely indicates delayed diagnosis or exceedingly rapid disease progression. In this context, having information on dementia diagnoses from outpatient care could enhance the accuracy of dementia identification strategy, allowing for earlier detection of some cases. Second, as dementia identification occurs later than the actual disease onset, there is a latency between the two events that may differ across educational levels. For instance, if diagnosis is delayed among low-educated individuals compared to their highly-educated counterparts, it could lead to an underestimation of educational disparities in dementia incidence and, conversely, to a potential overestimation of disparities in subsequent healthcare utilization. However, given the validated algorithm's overall performance, we expect any bias to be minimal. The identification of comorbidities and pharmaceutical treatments may be subjected to similar limitations. Finally, our follow-up spans the years of the Covid-19 pandemic, which undoubtedly influenced the propensity to interact with the Regional Health Service. Indeed, dementia patients represented a particularly vulnerable population during the Covid-19 pandemic, being exposed to higher risk of infection and mortality (Liu et al., 2020). To mitigate this limitation, we performed a sensitivity analysis restricting the period of analysis from 2012 to 2019, and the results were consistent. We opted to present the results from the broader follow-up period for completeness.

5. Conclusion

Our findings highlight that educational disparities persisted to a lesser extent beyond the risk of developing dementia in subsequent healthcare utilization. Disparities in dementia incidence were large and age-patterned among residents in Lazio Region, with low-educated individuals experiencing higher rates, particularly at younger ages. Moreover, while disparities in subsequent all-cause and potentially preventable hospitalizations were largely explained by pre-existing health conditions, disparities in emergency visits persisted regardless of these factors. This suggests that, while some disparities can be mitigated by addressing health conditions, others—especially related to emergency care—remain, underscoring the need for targeted interventions for low-educated dementia patients.

CRediT authorship contribution statement

Agostino Cristofalo: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis. **Silvia Cascini:** Writing – review & editing, Methodology, Data curation. **Giulia Cesaroni:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Eleonora Trappolini:** Writing – review & editing, Supervision, Investigation. **Nera Agabiti:** Writing – review & editing, Validation, Supervision. **Anna Maria Bargagli:** Writing – review & editing, Supervision, Project administration, Investigation, Conceptualization.

Ethics approval

This study involved human participants and was acknowledged and approved by the Lazio 1 Ethical Committee (N. 289, 29 March 2023). The requirement for informed consent was waived for the use of administrative data only. The National Statistical Programme, which includes the Lazio Region Longitudinal Study, is approved annually by the Italian Data Protection Authority (www.sistan.it).

Data availability

The dataset from this study is held securely in coded form at the Department of Epidemiology of the Lazio Regional Health Service. While legal data sharing agreements between the Department of Epidemiology of the Lazio Reginal Health Service and data providers (e.g. the Lazio Region) prohibit from making the dataset publicly available, access may be granted to those who meet pre-specified criteria for access to aggregated data. The full dataset creation plan and underlying analytic code are available from the authors upon request.

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Declaration of interest statement

No conflict of interest declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2025.118233.

Data availability

The authors do not have permission to share data.

References

Agerholm, J., Bruce, D., Ponce De Leon, A., Burström, B., 2013. Socioeconomic differences in healthcare utilization, with and without adjustment for need: an example from Stockholm, Sweden. Scand. J. Publ. Health 41 (3), 318–325. https://doi.org/10.1177/1403494812473205.

Andersen, R.M., 1968. A Behavioral Model of Families' Use of Health Services. Center for Health Administration Studies, University of Chicago, Chicago.

Andersen, R.M., 1995. Revisiting the behavioral model and access to medical care: does it matter? J. Health Soc. Behav. 36 (1), 1. https://doi.org/10.2307/2137284.

Anderson, T.S., Marcantonio, E.R., McCarthy, E.P., Herzig, S.J., 2020. National trends in potentially preventable hospitalizations of older adults with dementia. J. Am. Geriatr. Soc. 68 (10), 2240–2248. https://doi.org/10.1111/jgs.16636.

Appel, A.M., Brønnum-Hansen, H., Garde, A.H., Hansen, Å.M., Ishtiak-Ahmed, K., Islamoska, S., Mortensen, E.L., Osler, M., Nabe-Nielsen, K., 2022. Socioeconomic position and late-onset dementia: a nationwide register-based study. J. Aging Health 34 (2), 184–195. https://doi.org/10.1177/08982643211037200.

Arsenault-Lapierre, G., Bui, T., Godard-Sebillotte, C., Kang, N., Sourial, N., Rochette, L., Massamba, V., Quesnel-Vallée, A., Vedel, I., 2024. Sex differences in healthcare utilization in persons living with dementia between 2000 and 2017: a population-based study in quebec, Canada. J. Aging Health, 08982643241242512. https://doi.org/10.1177/08982643241242512.

Bacigalupo, I., Lombardo, F.L., Bargagli, A.M., Cascini, S., Agabiti, N., Davoli, M., Scalmana, S., Palma, A.D., Greco, A., Rinaldi, M., Giordana, R., Imperiale, D., Secreto, P., Golini, N., Gnavi, R., Lovaldi, F., Biagini, C.A., Gualdani, E., Francesconi, P., et al., 2022. Identification of dementia and MCI cases in health information systems: an Italian validation study. Alzheimer's & Dementia: Translational Research & Clinical Interventions 8 (1), e12327. https://doi.org/10.1002/trc2.12327.

Beltz, S., Gloystein, S., Litschko, T., Laag, S., van den Berg, N., 2022. Multivariate analysis of independent determinants of ADL/IADL and quality of life in the elderly. BMC Geriatr. 22 (1), 894. https://doi.org/10.1186/s12877-022-03621-3.

Billings, J., Zeitel, L., Lukomnik, J., Carey, T.S., Blank, A.E., Newman, L., 1993. Impact of socioeconomic status on hospital use in New York city. Health Aff. 12 (1), 162–173. https://doi.org/10.1377/hlthaff.12.1.162.

Bodryzlova, Y., Kim, A., Michaud, X., André, C., Bélanger, E., Moullec, G., 2022. Social class and the risk of dementia: a systematic review and meta-analysis of the prospective longitudinal studies. Scand. J. Publ. Health, 140349482211100. https://doi.org/10.1177/14034948221110019.

Bougea, A., Anagnostouli, M., Angelopoulou, E., Spanou, I., Chrousos, G., 2022. Psychosocial and trauma-related stress and risk of dementia: a meta-analytic systematic review of longitudinal studies. J. Geriatr. Psychiatr. Neurol. 35 (1), 24–37. https://doi.org/10.1177/0891988720973759.

Bynum, J.P.W., Rabins, P.V., Weller, W., Niefeld, M., Anderson, G.F., Wu, A.W., 2004. The relationship between a dementia diagnosis, chronic illness, medicare expenditures, and hospital use. J. Am. Geriatr. Soc. 52 (2), 187–194. https://doi.org/10.1111/j.1532-5415.2004.52054.x.

Chung, S., Providencia, R., Sofat, R., Pujades-Rodriguez, M., Torralbo, A., Fatemifar, G., Fitzpatrick, N.K., Taylor, J., Li, K., Dale, C., Rossor, M., Acosta-Mena, D., Whittaker, J., Denaxas, S., 2023. Incidence, morbidity, mortality and disparities in dementia: a population linked electronic health records study of 4.3 million individuals. Alzheimer's & Dementia 19 (1), 123–135. https://doi.org/10.1002/alz.12635.

Crimmins, E.M., Saito, Y., Kim, J.K., Zhang, Y.S., Sasson, I., Hayward, M.D., 2018. Educational differences in the prevalence of dementia and life expectancy with dementia: changes from 2000 to 2010. J. Gerontol.: Series B 73 (Suppl. l_1), S20–S28. https://doi.org/10.1093/geronb/gbx135.

De Ronchi, D., Berardi, D., Menchetti, M., Ferrari, G., Serretti, A., Dalmonte, E., Fratiglioni, L., 2005. Occurrence of cognitive impairment and dementia after the age of 60: a population-based study from northern Italy. Dement. Geriatr. Cognit. Disord. 19 (2–3), 97–105. https://doi.org/10.1159/000082660.

Di Carlo, A., Baldereschi, M., Amaducci, L., Lepore, V., Bracco, L., Maggi, S., Bonaiuto, S., Perissinotto, E., Scarlato, G., Farchi, G., Inzitari, D., For The Ilsa Working Group, 2002. Incidence of dementia, Alzheimer's disease, and vascular dementia in Italy. The ILSA study. J. Am. Geriatr. Soc. 50 (1), 41–48. https://doi.org/10.1046/j.1532-5415.2002.50006.x.

Galobardes, B., Lynch, J., Smith, G.D., 2007. Measuring socioeconomic position in health research. Br. Med. Bull. 81–82 (1), 21–37. https://doi.org/10.1093/bmb/ldm001.

Grande, G., Marengoni, A., Vetrano, D.L., Roso-Llorach, A., Rizzuto, D., Zucchelli, A., Qiu, C., Fratiglioni, L., Calderón-Larrañaga, A., 2021. Multimorbidity burden and dementia risk in older adults: the role of inflammation and genetics. Alzheimer's & Dementia 17 (5), 768–776. https://doi.org/10.1002/alz.12237.

Huisman, M., Kunst, A.E., Mackenbach, J.P., 2005. Inequalities in the prevalence of smoking in the European Union: comparing education and income. Prev. Med. 40 (6), 756–764. https://doi.org/10.1016/j.ypmed.2004.09.022.

ISTAT, 2022. Indicatori demografici—anno 2022. ISTAT. https://www.istat.it/it/files/2023/04/indicatori-anno-2022.pdf.

Korn, E.L., Graubard, B.I., Midthune, D., 1997. Time-to-Event analysis of longitudinal follow-up of a survey: choice of the time-scale. Am. J. Epidemiol. 145 (1), 72–80. https://doi.org/10.1093/oxfordjournals.aje.a009034.

Kristenson, M., Lundberg, J., Garvin, P., 2011. Socioeconomic differences in outpatient healthcare utilisation are mainly seen for musculoskeletal problems in groups with poor self-rated health. Scand. J. Publ. Health 39 (8), 805–812. https://doi.org/10.1177/1403494811423430.

LaMantia, M.A., Stump, T.E., Messina, F.C., Miller, D.K., Callahan, C.M., 2016. Emergency department use among older adults with dementia. Alzheimer Dis. Assoc. Disord. 30 (1), 35–40. https://doi.org/10.1097/WAD.0000000000000118.

Langa, K.M., 2015. Is the risk of Alzheimer's disease and dementia declining? Alzheimers Res. Ther. 7 (1), 34. https://doi.org/10.1186/s13195-015-0118-1.

Letenneur, L., Launer, J., Andersen, K., Dewey, M.E., Ott, A., Copeland, J.R.M., Dartigues, J.-F., Kragh-Sorensen, P., Baldereschi, M., Brayne, C., Lobo, A., Martinez-Lage, J.M., Stijnen, T., Hofman, A., for the EURODEM Incidence Research Group, 2000. Education and risk for Alzheimer's disease: sex makes a difference EURODEM pooled analyses. Am. J. Epidemiol. 151 (11), 1064–1071. https://doi.org/10.1093/oxfordjournals.aje.a010149.

Li, R., Li, R., Xie, J., Chen, J., Liu, S., Pan, A., Liu, G., 2023. Associations of socioeconomic status and healthy lifestyle with incident early-onset and late-onset dementia: a prospective cohort study. The Lancet Healthy Longevity 4 (12), e693–e702. https://doi.org/10.1016/S2666-7568(23)00211-8.

Liu, N., Sun, J., Wang, X., Zhao, M., Huang, Q., Li, H., 2020. The impact of dementia on the clinical outcome of COVID-19: a systematic review and meta-analysis. J. Alzheim. Dis. 78 (4), 1775–1782. https://doi.org/10.3233/JAD-201016.

Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne, C., Burns, A., Cohen-Mansfield, J., Cooper, C., Costafreda, S.G., Dias, A., Fox, N., Gitlin, L.N., Howard, R., Kales, H.C., Kivimäki, M., Larson, E.B., Ogunniyi, A., et al., 2020. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet 396 (10248), 413–446. https://doi.org/10.1016/S0140-6736(20)30367-6.

Livingston, G., Huntley, J., Liu, K.Y., Costafreda, S.G., Selbæk, G., Alladi, S., Ames, D., Banerjee, S., Burns, A., Brayne, C., Fox, N.C., Ferri, C.P., Gitlin, L.N., Howard, R., Kales, H.C., Kivimäki, M., Larson, E.B., Nakasujja, N., Rockwood, K., et al., 2024. Dementia prevention, intervention, and care: 2024 report of the Lancet standing

Commission. Lancet 404 (10452), 572–628. https://doi.org/10.1016/S0140-6736(24)01296-0.

Maccora, J., Peters, R., Anstey, K.J., 2020. What does (low) education mean in terms of dementia risk? A systematic review and meta-analysis highlighting inconsistency in measuring and operationalising education. SSM - Population Health 12, 100654. https://doi.org/10.1016/j.ssmph.2020.100654.

Mayer, F., Di Pucchio, A., Lacorte, E., Bacigalupo, I., Marzolini, F., Ferrante, G., Minardi, V., Masocco, M., Canevelli, M., Di Fiandra, T., Vanacore, N., 2018. An estimate of attributable cases of Alzheimer disease and vascular dementia due to modifiable risk factors: the impact of primary prevention in Europe and in Italy. Dement. Geriatr. Cogn. Dis. Extra 8 (1), 60–71. https://doi.org/10.1159/000487079.

McCarthy, E.P., Ogarek, J.A., Loomer, L., Gozalo, P.L., Mor, V., Hamel, M.B., Mitchell, S. L., 2020. Hospital transfer rates among US nursing home residents with advanced illness before and after initiatives to reduce hospitalizations. JAMA Intern. Med. 180 (3), 385. https://doi.org/10.1001/jamainternmed.2019.6130.

Meng, X., D'Arcy, C., 2012. Education and dementia in the context of the cognitive reserve hypothesis: a systematic review with meta-analyses and qualitative analyses. PLoS One 7 (6), e38268. https://doi.org/10.1371/journal.pone.0038268.

Motzek, T., Werblow, A., Tesch, F., Marquardt, G., Schmitt, J., 2018. Determinants of hospitalization and length of stay among people with dementia – an analysis of statutory health insurance claims data. Arch. Gerontol. Geriatr. 76, 227–233. https://doi.org/10.1016/j.archger.2018.02.015.

Noale, M., Limongi, F., Zambon, S., Crepaldi, G., Maggi, S., 2013. Incidence of dementia: evidence for an effect modification by gender. The ILSA Study. Int. Psychogeriatr. 25 (11), 1867–1876. https://doi.org/10.1017/S1041610213001300.

Pedroza, P., Miller-Petrie, M.K., Chen, C., Chakrabarti, S., Chapin, A., Hay, S., Tsakalos, G., Wimo, A., Dieleman, J.L., 2022. Global and regional spending on dementia care from 2000–2019 and expected future health spending scenarios from 2020–2050: an economic modelling exercise. eClinicalMedicine 45, 101337. https://doi.org/10.1016/j.eclinm.2022.101337.

Ponjoan, A., Garre-Olmo, J., Blanch, J., Fages, E., Alves-Cabratosa, L., Martí-Lluch, R., Comas-Cufí, M., Parramon, D., Garcia-Gil, M., Ramos, R., 2019. Epidemiology of dementia: prevalence and incidence estimates using validated electronic health records from primary care. Clin. Epidemiol. 11, 217–228. https://doi.org/10.2147/CLEP.S186590.

Ricciardi, W., Tarricone, R., 2021. The evolution of the Italian national health service. Lancet 398 (10317), 2193–2206. https://doi.org/10.1016/S0140-6736(21)01733-5.

Seblova, D., Quiroga, M., Fors, S., Johnell, K., Lövdén, M., Ponce De Leon, A., Svensson, A., Wicks, S., Lager, A., 2018. Thirty-year trends in dementia: a nationwide population study of Swedish inpatient records. Clin. Epidemiol. 10, 1679–1693. https://doi.org/10.2147/CLEP.S178955.

Sharp, E.S., Gatz, M., 2011. Relationship between education and dementia: an updated systematic review. Alzheimer Dis. Assoc. Disord. 25 (4), 289–304. https://doi.org/10.1097/WAD.0b013e318211c83c.

Shaw, B.A., Spokane, L.S., 2008. Examining the association between education level and physical activity changes during early old age. J. Aging Health 20 (7), 767–787. https://doi.org/10.1177/0898264308321081.

Sommerlad, A., Perera, G., Mueller, C., Singh-Manoux, A., Lewis, G., Stewart, R., Livingston, G., 2019. Hospitalisation of people with dementia: evidence from English electronic health records from 2008 to 2016. Eur. J. Epidemiol. 34 (6), 567–577. https://doi.org/10.1007/s10654-019-00481-x.

Stephan, B.C.M., Cochrane, L., Kafadar, A.H., Brain, J., Burton, E., Myers, B., Brayne, C., Naheed, A., Anstey, K.J., Ashor, A.W., Siervo, M., 2024. Population attributable fractions of modifiable risk factors for dementia: a systematic review and meta-analysis. The Lancet Healthy Longevity 5 (6), e406–e421. https://doi.org/10.1016/S2666-7568(24)00061-8.

Stern, Y., 2002. What is cognitive reserve? Theory and research application of the reserve concept. J. Int. Neuropsychol. Soc. 8 (3), 448–460. https://doi.org/10.1017/S1355617702813248.

Trappolini, E., Marino, C., Agabiti, N., Giudici, C., Davoli, M., Cacciani, L., 2020. Disparities in emergency department use between Italians and migrants residing in Rome, Italy: the Rome Dynamic Longitudinal Study from 2005 to 2015. BMC Public Health 20 (1), 1548. https://doi.org/10.1186/s12889-020-09280-6.

Tschorn, M., Schulze, S., Förstner, B.R., Holmberg, C., Spallek, J., Heinz, A., Rapp, M.A., 2023. Predictors and prevalence of hazardous alcohol use in middle-late to late adulthood in Europe. Aging Ment. Health 27 (5), 1001–1010. https://doi.org/10.1080/13607863.2022.2076208.

van Doorslaer, E., 2006. Inequalities in access to medical care by income in developed countries. Canadian Medical Association Journal 174 (2), 177–183. https://doi.org/10.1503/cmaj.050584.

Williamson, L.E., Evans, C.J., Cripps, R.L., Leniz, J., Yorganci, E., Sleeman, K.E., 2021. Factors associated with emergency department visits by people with dementia near the end of life: a systematic review. J. Am. Med. Dir. Assoc. 22 (10), 2046–2055.e35. https://doi.org/10.1016/j.jamda.2021.06.012.

Xu, W., Tan, L., Wang, H.-F., Tan, M.-S., Tan, L., Li, J.-Q., Zhao, Q.-F., Yu, J.-T., 2016. Education and risk of dementia: dose-response meta-analysis of prospective cohort studies. Mol. Neurobiol. 53 (5), 3113–3123. https://doi.org/10.1007/s12035-015-9211-5.

Yue, D., Ponce, N.A., Needleman, J., Ettner, S.L., 2021. The relationship between educational attainment and hospitalizations among middle-aged and older adults in the United States. SSM - Population Health 15, 100918. https://doi.org/10.1016/j.ssmph.2021.100918.