EDUCATIONAL DIFFERENCES IN THE DYNAMICS OF DISABILITY INCIDENCE, RECOVERY AND MORTALITY: FINDINGS FROM THE MRC COGNITIVE FUNCTION AND AGEING STUDY (MRC CFAS)

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SUMMARY

Background: This study aims to establish the extent of educational differences in the disability transitions of incidence, recovery and mortality in people aged 65 years and over, whether these can be explained by differentials in disease burden and their relative contribution to educational differences in prevalence and disability-free life expectancy (DFLE) .

Methods: A stratified random sample of 13004 participants in five areas in England and Wales were interviewed in 1991-1994 and followed up at two, six (one centre only) and ten years. Two levels of disability were analysed: mobility difficulty and ADL disability. We fitted logistic regression models to model educational differences in disability prevalence, incidence, recovery and mortality transitions. DFLE was calculated to assess the combined effect of the dynamic transitions.

Results: Those with 9 or less years education had higher ADL and mobility disability prevalence and higher incidence and lower recovery of mobility disability. Differences in disability incidence remained after adjustment for comorbidity. Women with the lowest education had shorter life expectancies (1.7 years less at age 65) than the most educated and had even shorter DFLE (1.9 years free of ADL disability and 2.8 years free of mobility difficulty at age 65).

Conclusions: Differentials in education continue to contribute to prevalence of disability at ages beyond 65 years in both men and women and independently of diseases. These appear to be driven predominantly by differentials in disability incidence that also compound to produce greater differentials in DFLE between education groups than in total years lived.

Word count 249

Keywords: MRC CFAS; Socioeconomic factors; Disability; Old age; Self-report; Activities of daily living

Key Messages

- Greater differentials in disability-free life expectancy than in total remaining life at age 65 were found between those with the highest and lowest levels of education in both men and women.
- These differentials appeared to be due to the lower educated experiencing more disability onset and less recovery once disabled.
- The greater incidence of and lower recovery from disability in the lower educated did not appear to be due to increased disease burden.

INTRODUCTION

The nature of the links between less privileged socio-economic status and health have been extensively studied in middle aged populations, but rather less so in older people, especially in the UK. For mortality, strong links have been demonstrated between socio-economic status and overall survival in older people[1]. Higher prevalence rates of disability (having difficulty undertaking everyday activities) have also been linked to various markers of less privileged social position in many studies, especially in the USA[2, 3] but also in Europe[4, 5] . This relationship has been demonstrated in Britain too, in terms of higher prevalence[6], earlier onset[7, 8] as well as the impact on life expectancy with and without disability[9-12].

However, disability is not a fixed state[13-15], but rather a dynamic one. The pool of prevalent disability is determined by incidence, recovery and mortality, both in those who were disabled, and those who were not. There is an established association between socio-economic status and disability incidence[16], but there is sparse evidence for a relationship with recovery from disability, and mortality from disabled states. In the Established Populations for Epidemiologic Studies of the Elderly (EPESE) populations in the USA, Melzer et al[17] demonstrated that the education excess of mobility disability was attributable to higher incidence rates in less privileged groups, and not differences in the other dynamic transitions. Similar findings were reported in Taiwanese[18] and Dutch[19] cohorts. If these findings apply more widely, using a variety of markers of social position, then there would be clear implications for the nature and timing of efforts to reduce health inequalities in old age. However, in a Chinese population, years of education were associated with both onset of and recovery from ADL difficulty[20].

In Britain, there have been several reports of higher incidence rates of disability by socio-economic status. Grundy and Glaser[13] reported evidence of higher incidence by social class, educational qualifications and housing tenure. Grundy and Holt[21] showed that disability status was associated with socio-economic and geographic variables, such as proportion of adult life spent unemployed and residence outside the Southeast of England. Ebrahim et al [22] found that manual social class plus lifestyle factors were strongly and independently associated with increased odds of incident locomotor disability over 12-14 years, in a cohort of British men whilst Adamson et al[23] reported higher incidence rates in locomotor disability by socioeconomic status in the younger elderly in Scotland. Breeze et al[24], using the Whitehall study male cohort, similarly reported raised rates of poor physical performance in old age by civil service grade, over a 29 year follow-up. Finally, a subjective report of adequacy of income was found to have the strongest relationship with incident ADL disability in Melton Mowbray[8]. Rates of recovery or mortality with or without disability have attracted little attention, due mainly to the lack of good large-scale cohort data. The only UK study to report rates of recovery by various measures of social disadvantage is a single-centre longitudinal study which found that both mortality and remission rates were higher for some measures of social disadvantage though numbers of transitions were small[9].

Socio-economic differences at an individual level are usually defined by education, occupation, income and material circumstances, or some combination of these markers[25]. Income and wealth (including dynamic changes in these) have been linked to health in old age[15,26, 27] and Robert and House[28] have provided evidence of an increasing relative impact of income over education on some measures of health with increasing age. In the UK occupation has been used as a marker of social status, and household tenure or car ownership have served as markers of material circumstances[8, 9, 29]. However, especially for older people, contemporaneous measures of social position can be misleading, failing to reflect changing status from middle age or earlier[30]. Full time education, as a marker, has the advantage of generally being completed early in adulthood and therefore less likely to suffer from reverse causation. It is also a good measure of long term economic position, at least in the USA[27].

The aim of the analysis presented here was to measure the strength of association between educational status and each of the dynamic transitions of disability, in an older UK population with follow-ups over ten years. Since a higher burden of disease and ill-health are often associated with lower socio-economic position and disability we sought to explore whether socio-economic differences in disability transitions were a result of higher disease burden. We further examined socio-economic differences in disability-free life expectancy (DFLE), itself a combination of the dynamic transitions.

METHODS

The Medical Research Council Cognitive Function and Ageing Study (MRC CFAS) is a longitudinal, population-based, multi-centre study whose original aims were to examine the descriptive epidemiology of dementia in England and Wales. Random samples of people aged 65 years or over were selected from the Family Health Service Authority lists in each of three urban (Newcastle, Nottingham and Oxford) and two rural centres (Cambridgeshire and Gwynedd) with over-sampling of those aged 75 years and over. A further urban centre (Liverpool) was part of MRC CFAS but this study had a different design and is excluded from this analysis. A full description of the CFAS study design can be found elsewhere[31].

All subjects were screened in their own homes by trained interviewers using a structured interview during 1992-1994 and provided information on socio-demographics (including level of education) and Activities of Daily Living (ADL). Participants were classified into three groups based on the number of years of full-time education undertaken (0-9 years, 10,11 years and 12+ years), reflecting basic/higher education as 9 years was the statutory time for this generation. Surviving individuals were re-interviewed at two and ten years and for one complete centre six years.

We used two measures of disability: mobility disability and ADL disability, collected for all participants, either at a further interview, or more detailed assessment and identically at follow-up interviews. Mobility disability was defined as having some difficulty or requiring help to get up and down stairs. Participants were classified as having ADL disability if they were unable to perform at least one of the following five

ADL without human help: transfer to and from a chair, put on shoes and socks, prepare a hot meal, get around outside and have a bath or an all over wash. Full details of the ADL disability classification are available elsewhere[8].

Comorbidity was examined using the number of health conditions reported (from stroke, angina, heart attack, intermittent claudication, chronic bronchitis, asthma (except in childhood), visual impairment, hearing impairment, treated diabetes, Parkinson's disease, high blood pressure confirmed by GP, depression and arthritis). Cognitive impairment was assessed using the Mini-Mental State Examination (MMSE)[32]. Responses to MMSE items of 'Don't know', 'no answer' and items that could not be answered due to sensory or dexterity problems were recoded to zero. Individuals were assigned to an MMSE category on the basis of completed items if this could be done unambiguously, otherwise the full score was recoded to missing.

We used MRC CFAS version 8.0 for this analysis, which has information on 13,004 people who took part in the initial screen. Only small amounts of data were missing at baseline: education (N=337, 2.6%), ADL disability (N=163, 1.3%), mobility disability (N=397, 3.1%), MMSE (N=257, 2.0%) and comorbidity (N=715, 5.5%). The response rate (as a percentage of those surviving) at two years was 79% and at ten years 75% and the median (maximum) time to last interview was 38 (143) months. Overall 12060 individuals (92.7%) had complete data at baseline and of these, 7229 (60.0%) had died by 31st December 2004 and 1024 (8.5%) had missing information on ADL or mobility status at all follow-ups but were known to be alive. MRC-CFAS oversampled those aged 75 years and over by design, so responses were reweighted to the population age sex distribution in each centre, to correct for the oversampling.

Logistic regression was used to model prevalence of disability (ADL and mobility), incidence to and recovery from disability and state-specific mortality. SAS version 9.1 was used for analysis. In all cases models for education with adjustment for age were fitted and then comorbidity and MMSE at baseline were added to examine whether education effects on disability were a result of greater disease burden in those with lower education. Additionally time between last report of no disability/disability and the event of interest (disability/no disability/death) was included as a covariate for analysis of incidence, recovery and mortality respectively. All analyses were performed for men and women separately.

Disability-free life expectancies (DFLE) were calculated from the baseline, two-, six- and ten-year follow-up data using Interpolated Markov Chain (IMaCH) software version 0.98h[33]. This technique partitions the time intervals between successive interviews into shorter steps and then models the resulting transition probabilities by multinomial logistic regression on age. Estimated transition probabilities then act as inputs to a multistate life table. We used education as a covariate but analysed men and women separately.

RESULTS

Of the study population for analysis (N=12060) 59.5% were female and 9.7% were aged 85 years and over. Years of education were negatively associated with age, 61.4% of the youngest age group having 0-9 years education compared to 66.9% of those aged 85+ years.

Prevalence of disability

Women reported more disability than men at baseline (mobility disability: men 26.3%, women 38.1%; ADL disability: men 11.5%, women 16.0%) (Table 1). In both men and women the prevalence of ADL and mobility disability were inversely related to years of education and were not wholly explained by age or greater comorbidity in the lower educated (Table 2). Much of the inequality in the prevalence of ADL disability by years of education was accounted for by cognitive function although inequalities in mobility difficulty remained even after adjustment for cognitive function.

Tables 1 and 2 here

Mortality

Low education conferred a higher risk of mortality from a disability-free state compared to the highest educated after adjustment for age (ADL disability: men OR=1.2, 95% CI 1.1 to 1.4; women: OR=1.3, 95% CI=1.2 to 1.6) although the increased risk disappeared after further adjustment for comorbidity and MMSE. Similar effects were seen for mortality from no mobility (men: OR=1.2, 95% CI 1.0 to

1.4; women: OR=1.5, 95% CI=1.3 to 1.8). Lower education did not appear to infer any increased risk of mortality from a disabled state, either ADL or mobility defined.

Incidence of disability

A total of 1480 transitions to ADL disability and 2182 to mobility disability were observed over the ten year follow-up (Table 1). Having 9 or less years of full-time education was associated with greater incidence of mobility disability in both sexes and ADL disability in women (Table 3). Odds ratios were attenuated slightly after adjustment by MMSE and comorbidity but differences remained significant.

Recovery from disability

There were 714 transitions from mobility disability to no disability but the number of transitions from ADL disability to no disability numbered only 211 and therefore modeling was not attempted for recovery from ADL disability (Table 1). Low educated men and women were significantly less likely to recover from mobility disability although confidence intervals were wide and the effect attenuated in women after adjustment for comorbidity and MMSE (Table 3).

Table 3 here

Disability-free life expectancy (DFLE)

As we had found evidence that the socially disadvantaged, as measured by years of education, experienced higher mortality and disability incidence, we examined the socio-economic differentials in disability-free life expectancy (DFLE). Compared to those with the highest education level (12+ years) women with the lowest level of education had shorter life expectancies (1.7 years less at age 65) and even fewer years free of disability (1.9 years free of ADL disability at age 65 and 2.8 years free of mobility disability at age 65) (Figure 1). In men, socio-economic differentials in life expectancy and mobility DFLE were of similar magnitude to those in women, the lowest educated men experiencing reductions of life expectancy at age 65 years of 1.1 years and 2.4 years fewer free of mobility disability, compared to those with the highest education (Figure 1). Differentials in ADL DFLE in men were smaller than those in women but still exceeded the differences in total years of life lived.

Figures 1 and 2 here

Although differences in ADL and mobility DFLE between those with the highest and lowest education narrowed with age, they were still evident across the whole age range in men and women and exceeded differences in life expectancy (Figures 1 and 2).

DISCUSSION

Using a population-based cohort of those aged 65 years and over, we have demonstrated that early life socio-economic differentials in transitions to, and to a lesser extent, from disability continue to contribute to prevalence differences in both sexes at ages beyond 65 years. Differences in the incidence of disability remained between those with the highest and lowest levels of education even after adjustment for a range of co-existing conditions, suggesting these were not simply a reflection of higher disease burden in the less educated. Moreover the differentials in incidence, recovery and mortality compound and result in differences in mobility DFLE at age 65 years of 2.8 years for women and 2.4 for men, exceeding differences in life expectancy. Our findings for mobility DFLE are similar in magnitude to differences in DFLE based on limiting longstanding illness between the most and least deprived areas of England (3.0 years for women and 2.7 for men)[12].

Our findings add to the evidence from other studies that differences in disability prevalence across educational groups persist at older ages. Although we found that relative differentials narrowed as rates increased with age, especially in women, absolute differences in disability prevalence between groups by years of education were maintained. Low education was associated with higher mortality in those previously disability-free but not in those who had already reported disability. Our findings of continued differences in disability incidence at older ages are consistent with others[13, 17-20] but we have shown that this is not simply a reflection of the greater prevalence of disease in the lower educated. Interestingly Ebrahim et al[34] found that socio-economic differences, measured by social class and income, in the incidence of severe but not mild disability was independent of diagnosed disease. More recent research has shown little impact of socio-demographic factors, including education, on declines in mobility though the time interval for onset was short (one year) and the study size small[35].

MRC-CFAS is one of the largest surveys to date to report recovery rates for the elderly population, but confidence intervals are wide, due to relatively small numbers in the disabled groups. Whilst lower rates of recovery for those with less education have been reported in a Chinese population[20], there was no such association in the EPESE study[17], the Taiwan Survey of the Elderly[18] or the Longitudinal Aging Study Amsterdam[19]. Some transitions to and from disability will be missed here, because of the two and ten-year intervals between follow-ups. In particular, recovery from ADL disability is often short-lived[36], but CFAS provides some evidence that more years of education are associated with higher rates of sustained recovery in men and women.

The strengths of MRC-CFAS are that it is a total population sample, including those in institutions, is nationally representative and has ten years of follow-up. As with any longitudinal study, our findings are limited by losses to follow-up though by ten years dropouts increasingly contribute to mortality events. In models for short and longer term dropout cognitive status accounts for most, but not all of selective dropout by education and social class[9, 37]. Adjustment for cognitive status did not materially change our findings, but the disabled and educationally disadvantaqed are likely to be under-represented making our differences conservative.

Socio-economic differences in DFLE, measured by education, income and occupation have been demonstrated in the US and Europe[38]. Though many of the studies reviewed by Crimmins and Cambois were based on cross-sectional data, there was a consensus that differences in DFLE or healthy life expectancy between education groups are greater than in total life expectancy. As in our study, differences have been found to persist into the oldest ages[39]. Though we could not formally assess whether differences in DFLE by level of education were explained by comorbidity, the analyses of incidence, recovery and mortality suggest that educational differences in DFLE would still remain after adjustment for comorbidity.

In the US differences in healthy life expectancy by education appear to have been widening over time[40]. Levels of education have changed substantially over the last two decades and compared to other demographic and socio-economic factors, education has been the most important contributor to the improvements in functioning in the US older population[41] although gains appear to have been confined to those with the highest level of education[3]. Although similar improvements in disability and functioning are yet to be seen in the UK, our findings suggest that differences in incidence rates between educational groups are the driving force for DFLE differences, as in the US[17].

Blane[42] proposes five possible causal processes to explain the relationship between education and health: (1) the long-term effect of childhood circumstances on adult health; (2) education is mediated through its influence on later occupation and income which themselves affect adult health; (3) education impacts on the ability to take in and act upon health education messages; (4) a further background variable affects both the capacity to complete education and maintain health; and (5) ill-health during childhood limits education and predisposes to later ill-health. The absence of childhood health measures limits our ability to confirm or dispute some of these causal mechanisms but previous findings of estimates of differences in DFLE by social class for men but not women in MRC CFAS[10] disputes the second explanation. Similarly the sustained differentials in incidence of disability between education groups with a baseline of no disability for all subjects and even after adjustment for comorbidity would give less credence to the first and last explanations, although the adjustment may well be incomplete. This leaves the possibility that education manifests itself through, in our case, the ability to adapt to increasing disability either through modifying tasks or employing technical aids. That differences in mobility DFLE were greater than the more severe ADL DFLE supports this since the ADL measure was based on requiring help from another person. Better self-report measures or objective performance measures would confirm this.

We have shown that socio-economic differences in DFLE persist into old age and appear to be driven by differential rates of disability incidence that are not wholly explained by differential disease burden. If transition rates remain the same over time within educational groups then the UK may see an overall compression of disability as educational differentials in DFLE exceeded those in total years lived. Rising levels of obesity alongside reduced physical activity may counteract this by raising incidence and reducing recovery rates but this can only be confirmed by longitudinal data on more recent cohorts.

Word count 3135

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Table 1: Numbers of prevalent cases of ADL[1] and mobility disability[2] at baseline and transitions by education and sex

	Complete baseline data (N=12060)							
	Men (N=4880)				Women (N=7180)			
	Years of education				Years of education			
Baseline state	**0-9**	**10,11**	**12+**	**Total (%)**	**0-9**	**10,11**	**12+**	**Total (%)**
ADL disability-free at baseline	2718	904	697	4319 (99.5)	3667	1378	989	6034 (84.0)
ADL disability-free to ADL disability[3] *(incidence)*	298	102	74	474	644	220	142	1006
ADL disability-free to death[3] *(mortality from no ADL disability)*	1428	427	342	2197	1413	448	344	2205
ADL disability at baseline *(prevalence)*	404	97	60	561 (11.5)	788	226	132	1146 (16.0)
ADL disability to no ADL disability[3] *(recovery)*	76	25	19	120	128	42	21	191
ADL disability to death[3] *(mortality from ADL disability)*	461	113	75	649	920	258	153	1331
Mobility disability-free at baseline	2222	767	607	3596 (73.7)	2590	1066	790	4446 (61.9)
Mobility disability-free to mobility disability[3] *(incidence)*	528	172	113	813	817	315	237	1369
Mobility disability-free to death[3] *(mortality from no mobility disability)*	1016	327	276	1619	851	310	214	1375
Mobility disability at baseline *(prevalence)*	900	234	150	1284 (26.3)	1865	538	331	2734 (38.1)
Mobility disability to no mobility disability[3] *(recovery)*	159	64	48	271	290	88	65	443
Mobility disability to death[3] *(mortality from mobility disability)*	878	213	141	1232	1487	396	285	2168
TOTAL	3122	1001	757	4880	4455	1604	1121	7180

[1]defined as unable to perform at least one of the following five ADL without human help
[2]defined as having some difficulty or requiring help to get up and down stairs
[3]between any consecutive waves

Table 2: Prevalent ADL and mobility disability at baseline by education and sex (Odds Ratios and 95% CI)

		Mobility disability			ADL disability		
	N	OR (95% CI)[1]	OR (95%CI)[2]	OR (95% CI)[3]	OR (95%CI)[1]	OR (95% CI)[2]	OR (95%CI)[3]
Men	4880						
Years of education							
12+	3122	1	1	1	1	1	1
10,11	1001	1.3 (1.0,1.7)*	1.3 (1.0,1.7)*	1.2 (1.0,1.6)	1.3 (0.9,1.9)	1.3 (0.9,1.8)	1.1 (0.8,1.6)
0-9	757	1.7 (1.4,2.1)***	1.6 (1.3,2.0)***	1.4 (1.2,1.8)***	1.8 (1.4,2.5)***	1.7 (1.3,2.3)***	1.2 (0.9,1.7)
Women	7180						
Years of education							
12+	4455	1	1	1	1	1	1
10,11	1604	1.3 (1.1,1.6)**	1.2 (1.0,1.5)*	1.2 (1.0,1.4)	1.4 (1.1,1.8)*	1.3 (1.0,1.7)*	1.1 (0.8,1.4)
0-9	1121	1.8 (1.5,2.1)***	1.6 (1.4,1.9)***	1.5 (1.3,1.7)***	1.6 (1.3,2.0)***	1.5 (1.2,1.9)***	1.1 (0.9,1.4)

[1]adjusted for age
[2]adjusted for age and comorbidity
[3]adjusted for age, comorbidity and MMSE category
* $p<0.05$, ** $p<0.01$. *** $p<0.001$

Table 3: ADL and mobility onset and mobility recovery over a ten year period for those with complete data at baseline by years of education and sex (Odds Ratios and 95% CI)

	Onset of mobility disability		Onset of ADL disability		Recovery from mobility disability	
	OR (95% CI)[1]	**OR (95%CI)[2]**	**OR (95% CI)[1]**	**OR (95%CI)[2]**	**OR (95% CI)[1]**	**OR (95%CI)[2]**
Men						
Years of education						
12+ years	1	1	1	1	1	1
10,11years	1.3 (1.0,1.7)*	1.4 (1.0,1.8)*	1.1 (0.8,1.5)	1.1 (0.8,1.5)	0.9 (0.6,1.4)	0.9 (0.6,1.4)
0-9 years	1.8 (1.4,2.2)***	1.7 (1.4,2.2)***	1.3 (1.0,1.7)	1.1 (0.8,1.5)	0.6 (0.4,0.9)*	0.6 (0.4,0.9)*
Women						
Years of education						
12+ years	1	1	1	1	1	1
10,11years	1.2 (1.0,1.4)	1.2 (0.9,1.4)	1.4 (1.1,1.7)*	1.2 (1.0,1.6)	0.7 (0.5,1.0)*	0.8 (0.5,1.1)
0-9 years	1.6(1.4,1.9)***	1.5 (1.2,1.8)***	1.8 (1.5,2.2)***	1.5 (1.2,1.9)***	0.7 (0.5,0.9)*	0.7 (0.5,1.0)

[1]adjusted by age
[2]adjusted by age, comorbidity and MMSE category
* $p<0.05$, ** $p<0.01$. *** $p<0.001$

Figure 1: Total life expectancy (TLE) and mobility disability-free life expectancy (mobility DFLE) at ages 65 and 85 by years of education and sex

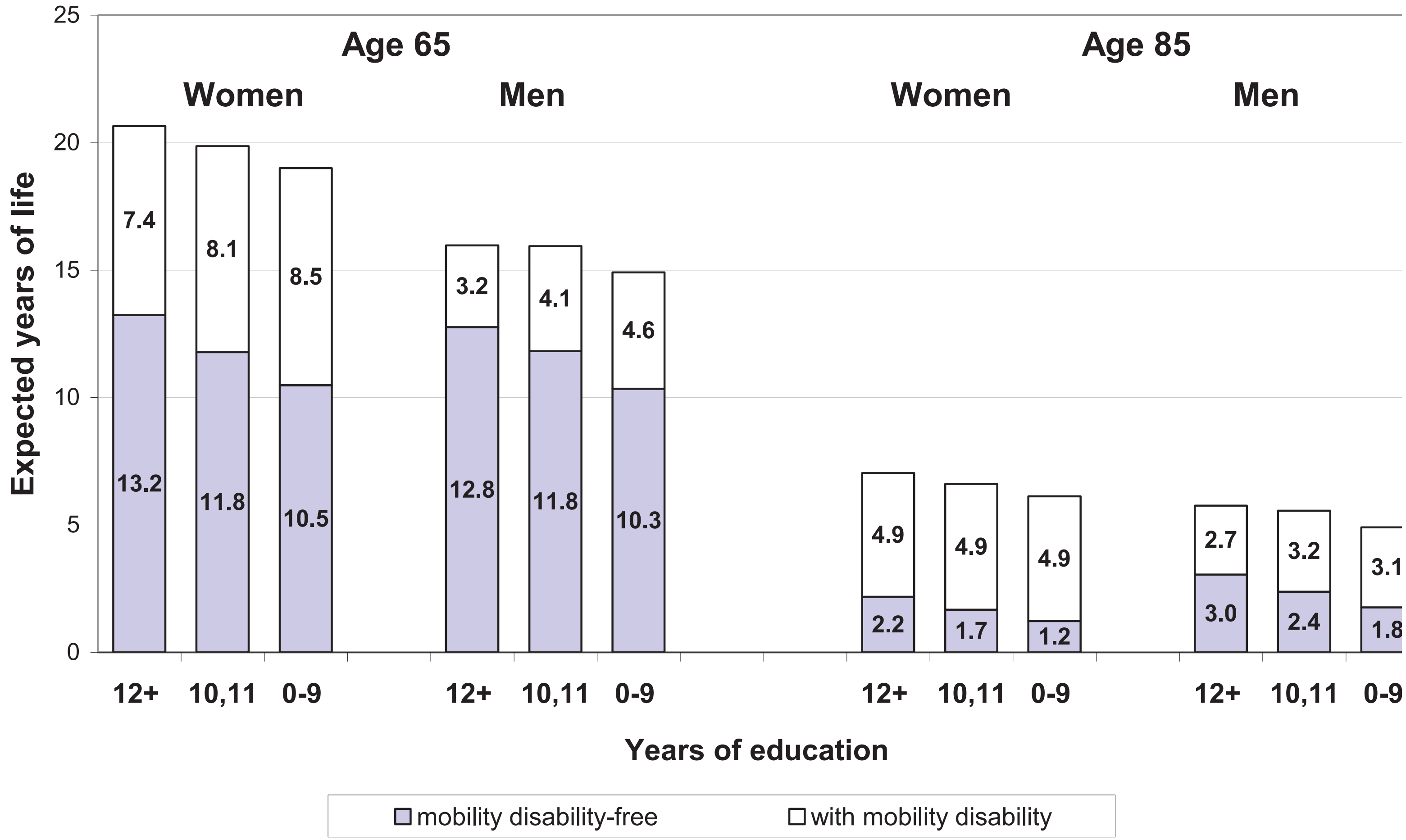

Figure 2: Total life expectancy (TLE) and ADL disability-free life expectancy (ADL DFLE) at ages 65 and 85 by years of education and sex