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Income in midlife and dementia related mortality over three decades: A Norwegian prospective study

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ABSTRACT

Studies on midlife income and dementia are scarce, and our main aim was to investigate midlife with later risk of dementia related mortality, adjusting for education and dementia related risk factors. The study population consisted of Norwegian men, aged 40–59 years in 1980 at income assessment, which participated in Norwegian health examination studies in the period 1980–2002 where risk factors such as cholesterol level, hypertension, smoking, cardiovascular disease, and diabetes were assessed. Dementia related mortality was defined as a dementia diagnosis on the death certificate until 2012. Cox regression was used. The study included 45,944 participants and 1062 dementia related deaths. There was no association between midlife income and dementia mortality risk (HR = 1.04, 95% confidence interval (CI) 0.85, 1.28 for the lowest fifth of income compared to those in the highest fifth). For total mortality, there was a strong inverse association with income (HR = 1.61, 95% CI 1.53, 1.69), which was attenuated when adjusting for education and risk factors, but still significant (HR = 1.27, 95% CI 1.20, 1.34). Lower educational attainment was significantly associated with increased dementia mortality risk, also after adjustment for income and other known risk factors (HR = 1.30, 95% CI 1.03, 1.64 comparing low versus high education). Midlife income was not associated with dementia related mortality, but low education was independently linked to increased risk of dementia related mortality. Our results support the cognitive reserve hypothesis suggesting that mental activity and not material resources are related to dementia related mortality.

1. Introduction

An increased risk of dementia related to lower educational attainment is well established [1–5], but there is still an ongoing debate if other measures of socioeconomic position, such as income, are involved in the etiology of dementia, or if the observed association is due to confounding by education. Regarding education, plausible explanations for the relationship with dementia have been proposed, which include brain [1] and cognitive reserves [6]. It is not likely that the education-dementia link is solely due to different lifestyle profiles between educational groups [7], as suggested in the brain battering hypothesis [8], or that education merely serves as a marker (proxy) for other factors related to dementia [3]. Education in itself might be a protective factor for dementia [3]. Studies on income and dementia are scarce; especially studies with income assessed early in life or in midlife, and the results are mixed [9–16]. Some studies find no association [12,14], while in other studies the initial inverse association between income and dementia disappears when education is accounted for, suggesting the association is spurious and confounded by education [13,17]. Again, in other studies it is reported that income is robust to such adjustment, and independently inversely related to dementia [9–11,18]. One of the few studies with midlife income, a Finnish study found no association between midlife income and dementia but only for late life income,

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where an inverse association was found [19]. Also, the income-dementia relationship seems to be more culture specific [16], than the education-dementia relationship, which is found universally.

Low income level has been found to be associated with shorter life and a range of adverse health outcomes [20], including poor cognitive functioning [21]. Norway, as one of the Scandinavian countries, has a generous welfare state with publicly funded health care services [22], so it is questionable if income poses barriers for health care in Norway, which next affects dementia risk. It has been suggested that factors acting across the lifespan might connect early life socioeconomic status and dementia risk [23]. Another possible mechanism linking income and dementia may be related to increased psychological distress in the lower income groups, which in turn might negatively affect the cardiovascular system and thereby increase dementia risk [24]. A third mechanism could be that the dementia disease, possibly in its early stage, affects income level downwardly [19]. This mechanism would mostly affect income in late life and not so much in midlife. Nevertheless, despite this list of possible explanations, the mechanisms linking income and dementia are largely unknown, if it exists.

With knowledge from our previous studies [25], our main aim was to investigate the association between midlife income (assessed at 40–59 years) and risk of dementia related mortality in a large cohort of Norwegian men, controlling for education and a range of lifestyle-related risk factors. We hypothesized that midlife income would not be associated with dementia related mortality, while higher educational attainment would be associated with reduced risk, independently of income level and risk factor profile.

2. Methods

2.1. Sample

Our study sample were men participating in either The Norwegian Counties Study (NCS) [26] during 1980–88 or The Cohort of Norway (CONOR) during 1994–2002 [27], in the age range of 40–59 years in 1980 (born 1920–39) at income and education assessment. Women were left out of analyses because of the large percentage with no personal pensionable income in this female birth cohort. Men in households with more than 10 household members were left out of the study sample (n = 63 dropped). NCS is a health examination study, with three waves, conducted in Oppland, Sogn og Fjordane and Finnmark counties during 1974–1988 [26], and CONOR is a joint health examination study of several regional studies performed during 1994–2002 [27]. For those participating in several waves of the NCS, results from their first wave, counting from year 1980, was included in our study. Study members were followed from 01.01.1980, and those participating in the health examination surveys after this date entered the study at the date of the health examination. Participants were followed until death, emigration or until 01.01.2012, whichever occurred first. The final study population included 43,887 men and 809,759 person years (Table 1). Mean age at entry into the study was 58.7 years (SD 11.3, range: 40–78 years), mean age in 1980 was 48.8 (SD 4.8, range: 40–59 years). The study population was followed for an average of 18.5 years (SD 9.4, range: 0–32 years), and age at exit was mean 77.1 years (SD 7.2, range: 42–92 years).

2.2. Dementia related mortality

Dementia related mortality was defined as a dementia diagnosis (ICD-9: 331.0, 294.1, 290.0–290.4; ICD-10: F00–F03 and G30) recorded on the death certificate in The Norwegian Cause of Death Registry, either as the underlying cause of death or as a contributory cause. During follow-up, 18,846 of the participants died (43%), and of these 1038 were dementia related deaths (Table 1).

2.3. Income and household size

Men's personal pensionable income in 1980 was linked to the participants using the Norwegian Tax Registry, and defined as the sum of labor income and income from self-employment, and transfers replacing such incomes, before tax is deducted. Income was grouped in five equally sized groups separately for two age groups (40–49 and 50–59 years), and collapsed in the analyses. There was 0.3% missing on the income variable (Table 1). Information about the household size in 1980 was registry based and grouped in four: single households, 2 in household, 3 in household and 4 or more in household. Four birth cohort groups were created: 1920–24, 1925–29, 1930–34 and 1935–39, and included in the analyses as a covariate.

2.4. Educational level, vascular conditions and life-style related risk factors

Highest attained educational level in 1980 was linked to the participants using the National Education Data Base, and classified into three groups: university degree and equivalents (high), advanced secondary qualifications (middle), and basic (public school/elementary school) (low) (Table 1). Participants who reported current or previous diabetes were categorized as having diabetes. Participants reporting cardiovascular disease (CVD), heart attack, angina, stroke, medical treatment of CVD, or symptoms of such a disease, were categorized as having a history of CVD. Smoking was dichotomized as daily smoker or not daily smoker. Leisure time physical activity was dichotomized as physically inactive (watching television mostly) or physically active (light walking, intermediate exercise activities, or intensive exercise). For the CONOR participants, two extra questions about physical activity in leisure time were used; one on hard activity (sweating or out of breath) and one on light activity (not sweating or out of breath). Those performing none or less than one activity per week were classified as physically inactive, while those having more than one activity per week were classified as physically active. Body mass index (BMI) was calculated based on measurements of height and weight as kg/m^2 and grouped as: <20 kg/m^2, 20–25 kg/m^2, 25–30 kg/m^2 and > = 30 kg/m^2. Based on a non-fasting blood sample, total cholesterol level was analyzed and grouped in four categories: 5.20 mmol/l, 5.20–6.49 mmol/l, 6.50–7.79 mmol/l and ≥7.80 mmol/l [28]. In the Counties Study, the second measurements of resting diastolic and systolic blood pressures were used in the analyses, while in CONOR mean values of the second and third measurements were used. The respondents were categorized as hypertensive if they had systolic pressure ≥160 mm Hg or diastolic pressure ≥100 mm Hg [29].

2.5. Statistics

To investigate the associations between income and dementia related mortality, a set of Cox regression models were specified, using attained age as the time variable and censoring competing events such as non-dementia related deaths or emigration. By using attained age as the time variable, all analyses are automatically adjusted by age. First, the model was adjusted by household size and birth cohort. Second, education was added to the model, and in the final model all covariates were added. All regression analyses were performed on the participants with non-missing values for all covariates in the final model; N = 41,035 (94%) and 937 dementia related deaths (17,290 total deaths). A similar approach was used to investigate the association between education and dementia related mortality, adjusted by income. In addition, analyses similar to those above were run using total mortality as outcome. This was done to investigate if certain trends in the results regarding dementia related mortality also applied to total mortality. Overall p-values in the regression models were estimated using a Wald-test, jointly testing if HRs for all income (or education) categories were equal to 1.00. The proportional hazards assumption was checked both on the basis of analysis of Schoenfeld residuals, and by