BMJ open

Unemployment in later working life eliminates health potential associated with cognition and education: Swedish register-based cohort study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003031
Article Type:	Research
Date Submitted by the Author:	10-Apr-2013
Complete List of Authors:	Montgomery, Scott; Örebro University Hospital and Örebro University, Clinical Epidemiology and Biostatistics Udumyan, Ruzan; Örebro University Hospital, Clinical Epidemiology and Biostatistics Magnuson, Anders; Örebro University Hospital, Clinical Epidemiology and Biostatistics Osika, Walter; Stockholm university/Karolinska Institute, Institute for stress research Sundin, Per-Ola; Örebro University Hospital, Department of Medicine Blane, David; Imperial College London, Department of Primary Care and Public Health
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Mental health
Keywords:	Unemployment, Suicide, Mortality

Unemployment in later working life eliminates health potential associated with cognition and education: Swedish register-based cohort study

Scott Montgomery,[1,2,3] Ruzan Udumyan,[1,2] Anders Magnuson, [1] Walter Osika, [4] Per-Ola Sundin,[2,5] David Blane[6]

1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85 Örebro, Sweden.
2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro, Sweden.
3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Insitutet, SE-171 76 Stockholm, Sweden.
4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
6. Department of Primary Care and Public Health, School of Public Health, Imperial College London W6 8RP, UK.

Correspondence: Professor Scott Montgomery
Clinical Epidemiology and Biostatistics
S-Huset
Örebro University Hospital
701 85 Örebro
Sweden
Telephone +46 19 602 6210
scott.montgomery@orebroll.se

Word count: 242 (abstract); 3371 (text)

Acknowledgements: This study received support from Economic and Social Research Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to prepare the tables.

The study sponsors (ESRC and Örebro University) had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and clarified codes and measures required for the analysis. SM drafted the manuscript and all contributors were involved in critical editing. SM will act as guarantor.

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro University to support this work. None of the authors, their spouses, partners, or children have financial or non-financial relationships that may be relevant to the submitted work.

Data sharing: no additional data available, as the ethical permission does not allow for provision of data to individuals not in the research group.

ABSTRACT

Objective To investigate if unemployment reduces health potential associated with higher cognitive function scores and qualifications.

Design and Setting National longitudinal cohort study using Swedish register data. The follow-up periods (1990-2001 and 2001-2010) were chosen as Sweden entered periods of significant economic contraction in 1990 and 2001.

Participants Men (n=234,782) born between 1952 and 1956 who participated in military conscription examinations.

Main outcome measure All-cause mortality.

Results Unemployment compared with employment in 1991 (ages 34 to 38 years) produced adjusted hazard ratios (with 95% confidence intervals) for all-cause mortality (3651 deaths) during follow-up to 2001 and after stratification by education of 2.35 (1.99 to 2.76) for compulsory education, 2.25 (1.97 to 2.58) for up to three years post-compulsory education and 1.90 (1.40 to 2.57) for more than three years post-compulsory education. When unemployment was compared with employment in 2001 (ages 45 to 49 years) with follow-up to 2010, the pattern of mortality risk (4271 deaths) stratified by education was reversed, producing adjusted hazard ratios of 2.81 (2.47 to 3.21) for compulsory education, 2.87 (2.58 to 3.19) for up to three years post-compulsory education and 3.44 (2.78 to 4.25) for more than three years post-compulsory education. Interaction testing confirmed effect modification by age/period (p=0.003). The degree of gradient reversal was slightly less pronounced after stratification by cognitive function but produced a similar pattern of results (p =0.004).

Conclusions Unemployment at older ages may eliminate health potential associated with higher cognitive function and qualifications.

Introduction

Economic recession and associated austerity measures result in increased unemployment, which is linked with poorer health and excess mortality through a variety of mechanisms.[1] During a recession, unemployment may be experienced by a broader spectrum of the working population rather than just more disadvantaged individuals. Does this atypical pattern of exposure to unemployment have unexpected health consequences?

Better cognitive function and higher levels of education are associated with greater potential for good health and reduced mortality risk in later life.[2-4] A review of intelligence in youth and all-cause mortality highlighted the likely importance of economic and social characteristics in adulthood in explaining the association.[3] Further clarification may be gained by examining how economic disadvantage such as unemployment modifies the association of intelligence in adolescence with adult mortality risk.

Better cognitive function and educational attainment confer protection against unemployment and facilitate a more rapid transition back to employment from unemployment, thus reducing the duration of exposure to unemployment-associated adversity. Therefore, health following experience of unemployment should be better among those with better cognitive function and the more highly qualified. However, in earlier studies we demonstrated that *unexpected* financial adversity is disproportionately damaging to health,[5-7] where adult economic disadvantage was experienced among those with pre-existing markers of better health and economic potential signalled by markers of childhood advantage. The disappointment paradox[7]

hypothesises that when individuals with greater potential and expectations encounter economic adversity in adulthood the experience is relatively unexpected, resulting in higher levels of stress and depression and thus also damage to other aspects of health.

Unexpected economic adversity even among those with greater personal resources may be a particularly damaging at *older* ages,[8] and obtaining another job at an equivalent level more difficult. As the mechanisms linking cognitive function and education with mortality may not be identical,[2] we examined these measures separately. This study uses Swedish register data to examine associations of unemployment with mortality among a cohort of men born between 1952 and 1956, to test the hypothesis that unemployment disproportionately eliminates health potential associated with better cognitive function and higher qualifications and that the effect varies by age. Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic recession and another period of significant economic contraction was beginning in 2001.

Methods

Study population

The cohort comprised all men born between 1st January 1952 and 31st December 1956 that were included in the Swedish Military Conscription Register.[9 10] At this time the majority of male Swedish citizens participated in the assessment for compulsory military service that took place in late adolescence and fewer than 4% of men were not involved due to chronic illness or disability. The assessments were between 1970 and 1975 and the majority at ages 18 and 19 years, with a small number after this time at later ages. A total of 284,198 men were identified and 2,564 were excluded due to data

inconsistencies such as errors in the personal identification number, female sex or uncertain vital status. We then excluded 225 men from the analysis with improbable measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This resulted in a sample of 272,768 men with data at the start of follow-up in December 1990. We then excluded 35,161 men with missing data for: census (18,178); education (2,440); or the conscription assessments (28,483) that may have resulted from loss of records. The sample available for the main analysis comprised 234,782 men.

Measures

The conscription examination in late adolescence provided the following measures. Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic blood pressure were measured after rest in recumbent men using a sphygmomanometer. Physical working capacity was assessed using an electronically braked ergonometer for the maximum load sustained for six minutes, or an estimate was derived from a nomogram for shorter duration. Cognitive testing covered four domains: linguistic understanding (40 questions), spatial recognition (identifying geometric shapes), general knowledge (40 questions) and ability to follow mechanical instructions (problems presented as diagrams requiring knowledge of mechanics and basic physics). The results of the cognitive function tests were transformed into a single score with a value on a normalized standard scale ranging from 1 to 9. The conscripts underwent a psychological examination to assess their potential ability to cope with warfare and therefore providing an indication of their stress resilience, producing a score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in

Swedish,[11] but it has been used in research reported in English.[12] The medical assessment produced a score of 0 to 9 to indicate the severity of any medical problems, such that 9 indicated no problem, with a decreasing score indicating increasing severity to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-defined problem (n=22).

Statistics Sweden provided socioeconomic and demographic data using the registers they administer,[13] including information on vital status and emigration from the Total Population register. Childhood social and material circumstances were estimated using data from the 1960 census, where the head of the household's occupation was characterised as manual, agricultural, farm owners/managers, office workers, business owners/managers, and others. The person per room ratio was divided into quarters of its distribution. The Longitudinal database of Education, Income, and Occupation (LISA) was used to obtain information on level of attained education in 1990, employment status in 1985, as well employment status and receipt of disability/chronic disease benefits in 1990 and 2001. Attained education – based on the duration of education required for the qualification - was divided into three categories: compulsory (up to nine years); up to three years post-compulsory; and over three years post-compulsory. Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of disability/chronic disease benefits at any time earlier in the year was recorded.

The Cause of Death Register[14] provided ICD codes on causes of death, including for suicide, where we also included undetermined intent as possible suicide.

Statistical analysis

Cox regression was used to examine the association of unemployment (compared with employment) with subsequent mortality risk over two periods: unemployment in 1990 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who received disability/chronic disease benefits at entry to either follow-up period were excluded from analysis in that period. Follow-up was to death, emigration or the end of the study period, whichever occurred first. The analysis was adjusted for socioeconomic index of parents and household crowding in 1960, and the following conscription measures: BMI in categories as in table 1, height (continuous), physical working capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8, and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the later follow-up period) and region of residence. Attained age was used as the underlying time-scale for all models to achieve the most efficient adjustment for age. The analyses were stratified by the cognitive function score divided into equal thirds of its distribution and then by the three-category education variable. Further analyses excluded mortality due to suicide (including where the cause of death was recorded as undetermined intent). Analyses then excluded the first four years of follow-up after 1990 and 2001 to allow for 'selection to wear off'.[15 16]

A Cox regression model with follow-up over the entire study period (1990 to 2010) assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for the association with mortality for the combination of unemployment with cognitive function or with education. Unemployment was modelled as a time-dependent covariate and the analysis was adjusted for the potential confounding factors described above.

The statistical software used was Stata version 12/SE for Windows (StataCorp, College Station, Texas). Tests were 2-sided and statistical significance was defined as $p<0.05$ and 95% confidence intervals that do not include 1.00.

Ethical permission

Ethical permission to conduct this project was granted by the Uppsala Regional Ethics Committee (Dnr 2009/306).

Results

All of the characteristics investigated were statistically significantly associated with unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than 0.001, p values are not presented. Unemployment and receipt of a disability pension in both periods were associated with lower parental SEI, greater household crowding, BMI indicating underweight or obesity, diagnoses of more severe diseases at conscription, low stress resilience, lower level qualifications, shorter stature, lower physical working capacity, and lower cognitive function score. Higher diastolic blood pressure was associated with unemployment and disability pension, but the pattern is more complex for systolic blood pressure. The total number unemployed in 2001 was greater than in 1990 and the number on disability/chronic sickness benefit was notably greater in 2001. Overall, the distribution of educational attainment and cognitive function score among the employed was very similar between the two periods, but a higher proportion of those who experienced unemployment during the second period had lower qualifications and cognitive function scores.

During the period 1990 to 2001, unemployment compared with employment in 1990 was associated with a statistically significantly raised risk of mortality in each of the cognitive function and education strata, both before and after adjustment for the potential confounding factors (table 2). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. The results are graded by cognition and education, with the highest unemployment-related mortality risk among men with the lowest cognitive function scores and education. Exclusion of deaths due to suicide altered the gradient of risk between the first two strata, but men with the highest cognitive function scores and qualifications remained at lowest risk of mortality if they experienced unemployment. Some reduction in magnitude of risk, but without loss of statistical significance, was observed when deaths during the first four years of follow-up were excluded to allow for the 'wearing off' of direct health selection.

During the period 2001 to 2010, unemployment compared with employment in 2001 was associated with a statistically significantly raised risk of mortality in each of the education strata both before and after adjustment for the potential confounding factors (table 3). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. In contrast with the earlier period, the unemployment-related mortality risk, when stratified by cognition or education, is reversed and consistently higher for the strata of those with the highest levels of cognitive function or education. It is noteworthy that the absolute rate of unemployment-related mortality is much more similar across the cognition and education strata; even though there is more of a gradient among the employed. In all of the adjusted models, after exclusion of death by suicide, and after allowing 'selection to

wear off', the gradient of unemployment-related mortality remains reversed or eliminated compared with the earlier period: those with the higher level cognitive function scores and qualifications had higher hazard ratios for mortality associated with unemployment.

The interaction tests to assess effect modification by age/period are statistically significant for both cognitive function (p=0.004) and education (p=0.003), consistent with higher mortality among in men with better cognitive function or education when they experience unemployment at a later age.

Discussion

Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was associated with all-cause mortality: men with poorer cognitive function test scores and lower-level educational attainment were at greater relative risk (measured by hazard ratios) than men with higher qualifications. Unemployment in 2001 when the men were aged 45 to 49 years was also associated with subsequent mortality, but the gradient was reversed, such that the more intelligent and more highly qualified men were at greater relative risk of mortality following unemployment. The gradient of absolute unemployment-associated mortality rate, across cognition and education strata was attenuated substantially by unemployment at an older age in 2001.

Previous research using data from the USA found that low income was a greater relative risk for ischaemic heart disease and depression among individuals with markers of a relatively privileged childhood and higher qualifications.[5 7] Data from older adults in Britain revealed that similar economic adversity eliminated the health potential for a

lower depression risk associated with markers of earlier advantage.[6] We hypothesised that this *unexpected* adversity results in a form of disappointment, thus increasing the risk of disease through behavioural change and the systemic consequences of stress. This study is an extension of the disappointment paradox concept but using longitudinal rather than cross-sectional data. Unemployment at an older age among the more highly qualified and those with higher cognitive function scores may represent a stressful exposure that is more unexpected or more difficult to cope with than unemployment experienced among men with fewer qualifications or lower cognitive function scores. As we are concerned with unemployment as marker of socioeconomic adversity we did not adjust for other contemporaneous economic measures collinear with unemployment. The earlier research used diagnoses as the outcome[5-7] and the results could theoretically have been influenced by more highly educated individuals seeking health care: the use of mortality in this study is not at similar risk of bias through health service use.

It has long been observed that suicide rates increase both during periods of economic recession and also during phases of rapid economic growth; arguing that weakened social norms, rather than poverty alone, reduces social cohesion and thus increases suicide risk.[17] A sense of coherence is relevant to an individual's adaptive capacity for social stress[18] and unemployment may be damaging in this respect. Those with higher cognitive function and qualifications, signalling more advantages in earlier life, may be less well adapted to coping with unemployment-related stress.[6 7] This theoretical framework not only potentially explains associations with suicide (the risk of which can vary by age[19]), as our results are similar after exclusion of suicide. Poorer adaptation to social adversity has also been linked to increased risk of stroke,[20] indicating effects on the cardiovascular and possibly other systems.

Interaction analysis confirmed that the pattern of risk changed between the periods such that the greater risk of mortality among men with better cognition and qualifications who experienced unemployment at an older age was disproportionately higher (a multiplicative effect). Older people who have less possibility to return to work may find the consequence of the associated economic adversity more challenging,[8] particularly during a period of economic contraction, despite the resources signalled by higher cognition and qualifications. This unemployment-associated risk of ill health may continue to increase with age.

Health selection can help to explain associations between unemployment and disease.[21] Direct health selection is where pre-existing illness increases the risk of unemployment. We tackled this by excluding men with disability and sickness benefits at study entry and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we excluded events (deaths) in the initial years of follow-up after unemployment to allow selection to 'wear off' when a high proportion of those with the most serious diseases pre-dating unemployment are expected to die,[15] as used in other studies of unemployment and mortality, including a previous study of unemployment in Sweden.[16] The earlier Swedish study presented evidence of direct health selection as there was statistically significant excess mortality in the first four years following unemployment but not subsequently.[16] Therefore we excluded the first four years of the follow-up in a sub-analysis. Even though the men who experienced unemployment in the second period of our study may have been more selected in terms of health, our procedures to tackle direct selection make this unlikely as an explanation for the reversal of the unemployment-mortality gradient by cognition or education.

Indirect health selection is where personal characteristics linked with raised unemployment risk are also risks for poor health.[21 22] We adjusted for a variety of measures relevant to future health and mortality risk, including chronic illnesses, height,[23] blood pressure,[9] BMI,[24 25] cognition,[2 3] markers of physical fitness[25] and stress resilience. Men with the most severe disabilities or chronic illness preventing military service would not have undergone some of the tests at conscription and are thus not included in the analysis. Indirect health selection is unlikely to explain the disappearance at a later age of the relatively protective association with higher qualifications and cognition, as the opposite effect might be expected.

It should be emphasised that unemployment remained less common among the more highly educated men and those with higher cognitive function. This means that support and benefits will remain a bigger issue for the less highly qualified and more disadvantaged. Unemployment can result in persistent disadvantage, including through subsequent unstable employment,[26-28] so when experienced at an earlier age it can cause harm across an entire adult life. While it remains possible that earlier exit from the labour market helps to explain these results, it does not alter the fact that unemployment among older men is relatively more damaging across the social spectrum, suggesting this is a 'critical period' where interventions might be focused.[29]

The experience of unemployment can contribute to the risk of ill-health through several mechanisms.[1] Behavioural change following unemployment, such as increases in smoking (or failure to give up) and an unhealthy diet[26] can increase the risk of cardiovascular disease and cancer. The financial disadvantage associated with

unemployment can persist even after finding a new job[26] and the association of poverty with mortality is well known.[30] Depression and stress resulting from unemployment is also likely to be relevant, as this has may raise mortality risk through behavioural and possibly systemic mechanisms.[31] Stressful events and circumstances have been linked to an increase in mortality due to suicide and cardiovascular disease.[32] The mechanisms linking cognitive function and education with mortality may not be identical,[2] but the pattern of unemployment-related mortality risk is similar when stratified by cognition or education.

Limitations

Potential limitations of the study include its inclusion of only men. This was necessary as the detailed baseline data on health and function were collected during military conscription, which at the time was only available to men. Disentangling age and period effects in a single cohort can be problematic. The two time points differed in unemployment rate: the proportion unemployed was larger in the second period, thus possibly altering selection effects. To tackle possible selection bias we adjusted for multiple markers of susceptibility. We also excluded events during the first part of the follow-up period to allow direct health selection to 'wear off'. The study focused on unemployment only at two time points and these represent times when Sweden was entering periods of economic contraction: these were chosen when the study was designed and information on unemployment at other times was not included in our dataset. These measures will underestimate the experience of unemployment and does not take duration of unemployment into account. This is likely to make our estimates less precise rather than creating spurious results. The focus of the study was on mortality as an objective endpoint. While this will underestimate the damage to health

associated with unemployment substantially, it makes it more feasible to tackle the effects of direct health selection, as less serious health events that could influence unemployment risk will not contribute so notably to mortality in the first years following unemployment that we excluded from the 'selection wearing off' analysis. Mortality is more likely to occur at older ages and causes of mortality vary by age.

Unemployment during periods of economic contraction is associated with raised mortality that may not be explained fully by direct or indirect health selection into unemployment. With increasing age, the experience of unemployment may be unexpectedly harmful to those with better cognition, higher qualifications and associated resources. This highlights the importance of supporting the entire population who experience unemployment during a recession and the greater vulnerability of older workers, irrespective of their health potential indicated by markers of protection such as cognitive function and education.

ARTICLE SUMMARY

Article focus

- Unemployment is associated with poor health and excess mortality, which is explained a variety of mechanisms.
- Higher qualifications and better cognitive function are associated with the potential for better health.
- Economic adversity has been shown to eliminate health potential disproportionately among individuals who were previously advantaged, so unemployment may have this effect among those with higher qualifications and better cognitive function.

Key messages

- Unemployment in later working life is more likely to eliminate heath potential associated with cognitive function and qualifications than unemployment at a younger age.
- This emphasises the importance of supporting all older workers who become unemployed, including those with characteristics signalling higher levels of health potential.

Strengths and limitations of this study

- The study benefits from use of a large longitudinal cohort with prospectively recorded information.

- Unemployment is only measured at limited number of time points, so the study cannot examine duration of exposure.

- The use of Swedish military conscription data limited the study to men, so it is not known if findings would be similar among women.

1. Janlert U, Hammarstrom A. Which theory is best? Explanatory models of the relationship between unemployment and health. *BMC public health* 2009;9:235.
2. Lager A, Bremberg S, Vagero D. The association of early IQ and education with mortality: 65 year longitudinal study in Malmo, Sweden. *Bmj* 2009;339:b5282.
3. Calvin CM, Deary IJ, Fenton C, Roberts BA, Der G, Leckenby N, et al. Intelligence in youth and all-cause-mortality: systematic review with meta-analysis. *International journal of epidemiology* 2011;40(3):626-44.
4. Batty GD, Wennerstad KM, Smith GD, Gunnell D, Deary IJ, Tynelius P, et al. IQ in early adulthood and mortality by middle age: cohort study of 1 million Swedish men. *Epidemiology* 2009;20(1):100-9.
5. Osika W, Ehlin A, Montgomery SM. Does height modify the risk of angina associated with economic adversity? *Economics and human biology* 2006;4(3):398-411.
6. Montgomery SM, Netuveli G, Hildon Z, Blane D. Does financial disadvantage at older ages eliminate the potential for better health? *Journal of epidemiology and community health* 2007;61(10):891-5.
7. Osika W, Montgomery SM. Economic disadvantage modifies the association of height with low mood in the US, 2004: the disappointment paradox. *Economics and human biology* 2008;6(1):95-107.
8. McKee M, Stuckler D. Older people in the UK: under attack from all directions. *Age and ageing* 2013;42(1):11-3.
9. Sundstrom J, Neovius M, Tynelius P, Rasmussen F. Association of blood pressure in late adolescence with subsequent mortality: cohort study of Swedish male conscripts. *Bmj* 2011;342:d643.
10. Whitley E, Batty GD, Gale CR, Deary IJ, Tynelius P, Rasmussen F. Intelligence in early adulthood and subsequent risk of unintentional injury over two decades: cohort study of 1 109 475 Swedish men. *Journal of epidemiology and community health* 2010;64(5):419-25.
11. Lothigius J. *Verksamhetsinstruktion för Psykologer VIP95 (Psychological Test Manual used by the Swedish National Service Administration VIP95)*. Karlstad, 1995.
12. Nilsson PM, Nyberg P, Ostergren PO. Increased susceptibility to stress at a psychological assessment of stress tolerance is associated with impaired fetal growth. *International journal of epidemiology* 2001;30(1):75-80.
13. Statistics Sweden. http://www.scb.se/default___2154.aspx, (Accessed 25 March 2013).
14. The Cause of Death Register. http://www.socialstyrelsen.se/register/dodsorsaksregistret, (Accessed 25 March 2013).
15. Moser KA, Goldblatt PO, Fox AJ, Jones DR. Unemployment and mortality: comparison of the 1971 and 1981 longitudinal study census samples. *British medical journal* 1987;294(6564):86-90.
16. Lundin A, Lundberg I, Hallsten L, Ottosson J, Hemmingsson T. Unemployment and mortality--a longitudinal prospective study on selection and causation in 49321 Swedish middle-aged men. *Journal of epidemiology and community health* 2010;64(1):22-8.
17. Durkheim É. *Suicide: a study in sociology; translated by John A Spaulding and George Simpson*. New York: The Free Press of Glencoe, 1951.

18. Surtees PG, Wainwright NW, Khaw KT. Resilience, misfortune, and mortality: evidence that sense of coherence is a marker of social stress adaptive capacity. *Journal of psychosomatic research* 2006;61(2):221-7.
19. Varnik P. Suicide in the world. *International journal of environmental research and public health* 2012;9(3):760-71.
20. Surtees PG, Wainwright NW, Luben RL, Wareham NJ, Bingham SA, Khaw KT. Adaptation to social adversity is associated with stroke incidence: evidence from the EPIC-Norfolk prospective cohort study. *Stroke; a journal of cerebral circulation* 2007;38(5):1447-53.
21. Bartley M, Ferrie J. Do we need to worry about the health effects of unemployment? *Journal of epidemiology and community health* 2010;64(1):5-6.
22. Montgomery SM, Bartley MJ, Cook DG, Wadsworth ME. Health and social precursors of unemployment in young men in Great Britain. *Journal of epidemiology and community health* 1996;50(4):415-22.
23. Magnusson PK, Gunnell D, Tynelius P, Davey Smith G, Rasmussen F. Strong inverse association between height and suicide in a large cohort of Swedish men: evidence of early life origins of suicidal behavior? *The American journal of psychiatry* 2005;162(7):1373-5.
24. Magnusson PK, Rasmussen F, Lawlor DA, Tynelius P, Gunnell D. Association of body mass index with suicide mortality: a prospective cohort study of more than one million men. *American journal of epidemiology* 2006;163(1):1-8.
25. Bellocco R, Jia C, Ye W, Lagerros YT. Effects of physical activity, body mass index, waist-to-hip ratio and waist circumference on total mortality risk in the Swedish National March Cohort. *European journal of epidemiology* 2010;25(11):777-88.
26. Wadsworth ME, Montgomery SM, Bartley MJ. The persisting effect of unemployment on health and social well-being in men early in working life. *Social science & medicine* 1999;48(10):1491-9.
27. Virtanen P, Vahtera J, Kivimaki M, Pentti J, Ferrie J. Employment security and health. *Journal of epidemiology and community health* 2002;56(8):569-74.
28. Ferrie JE, Shipley MJ, Stansfeld SA, Marmot MG. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *Journal of epidemiology and community health* 2002;56(6):450-4.
29. Bartley M, Blane D, Montgomery S. Health and the life course: why safety nets matter. *Bmj* 1997;314(7088):1194-6.
30. Thomas B, Dorling D, Smith GD. Inequalities in premature mortality in Britain: observational study from 1921 to 2007. *Bmj* 2010;341:c3639.
31. Cohen F, Kemeny ME, Zegans LS, Johnson P, Kearney KA, Stites DP. Immune function declines with unemployment and recovers after stressor termination. *Psychosomatic medicine* 2007;69(3):225-34.
32. Fang F, Fall K, Mittleman MA, Sparen P, Ye W, Adami HO, et al. Suicide and cardiovascular death after a cancer diagnosis. *The New England journal of medicine* 2012;366(14):1310-8.

Table 1. Population characteristics and subsequent unemployment in 1990 and 2001

	1990			2001		
	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)
Parental SEI 1960						
Manual workers	91 878 (41.5)	5274 (40.2)	1380 (46.9)	82 938 (41.2)	7413 (43.6)	5049 (47.3)
Agricultural workers	8592 (3.9)	471 (3.6)	120 (4.1)	7693 (3.8)	743 (4.4)	507 (4.7)
Farm owners/managers	22 510 (10.2)	948 (7.2)	206 (7.0)	20 931 (10.4)	1373 (8.1)	770 (7.2)
Office workers	61 748 (27.9)	3774 (28.7)	684 (23.2)	56 698 (28.1)	4199 (24.7)	2389 (22.4)
Business owners/managers	23 701 (10.7)	1569 (12.0)	263 (8.9)	21 690 (10.8)	1893 (11.1)	982 (9.2)
Others/unknown	13105 (5.9)	1093 (8.3)	291 (9.9)	11 557 (5.7)	1362 (8.0)	986 (9.2)
Household crowding, 1960						
≤2 people/ room	173 804 (78.5)	9883 (75.3)	2085 (70.8)	159 131 (79.0)	12 412 (73.1)	7538 (70.6)
> 2 people/ room	47 730 (21.5)	3246 (24.7)	859 (29.2)	42 376 (21.0)	4562 (26.9)	3145 (29.4)
BMI categories, kg/m²						
Underweight (<18.5)	25 476 (11.5)	1664 (12.7)	481 (16.3)	22 999 (11.4)	2106 (12.4)	1525 (14.3)
Normal weight (18.5, <25)	179 381 (81.0)	10 456 (79.6)	2234 (75.9)	163 723 (81.2)	13 451 (79.2)	8142 (76.2)
Overweight (25.0, <30)	14536 (6.6)	833 (6.3)	183 (6.2)	12 955 (6.4)	1191 (7.0)	837 (7.8)
Obese (≥30.0)	2141 (1.0)	176 (1.3)	46 (1.6)	1839 (0.9)	235 (1.4)	179 (1.7)
Summary disease score						
Very significant problem (0)	10 560 (4.8)	1613 (12.3)	897 (30.5)	8212 (4.1)	1920 (11.3)	2159 (20.2)
Significant problem (2-3)	6468 (2.9)	586 (4.5)	249 (8.5)	5481 (2.7)	782 (4.6)	698 (6.5)
Fairly significant (4-5)	16671 (7.5)	1061 (8.1)	246 (8.4)	14 782 (7.3)	1548 (9.1)	1032 (9.7)
No serious problem (6-8)	88 816 (40.1)	4832 (36.8)	830 (28.2)	81 106 (40.2)	6472 (38.1)	3774 (35.3)
No diagnosis (9)	98 997 (44.7)	5037 (38.4)	722 (24.5)	91 909 (45.6)	6260 (36.9)	3018 /28.3)
Ill-defined problem (1)	22 (0.0)	0 (0.0)	0 (0.0)	18 (0.0)	1 (0.0)	2 (0.0)
Stress resilience						
Low (1-3)	45 221 (20.4)	4407 (33.6)	1750 (59.4)	38 222 (19.0)	5927 (34.9)	5108 (47.8)
Moderate (4-6)	122 546 (55.3)	6092 (46.4)	1005 (34.1)	112 943 (56.0)	8227 (48.4)	4494 (42.1)
High (7-9)	53 767 (24.3)	2630 (20.0)	189 (6.4)	50 342 (25.0)	2829 (16.7)	1081 (10.1)
Education						
Compulsory	54 698 (24.7)	3634 (27.7)	1345 (45.7)	48 367 (24.0)	5254 (30.9)	4089 (38.3)
≤ 3 years post-compulsory	103 251 (46.6)	6595 (50.2)	1388 (47.1)	93 225 (46.3)	9019 (53.1)	5577 (52.2)
> 3 years post-compulsory	63 585 (28.7)	2900 (22.1)	211 (7.2)	59 915 (29.7)	2710 (16.0)	1017 (9.5)
Height*	178.7 (6.4)	178.4 (6.5)	177.7 (6.7)	178.8 (6.4)	178.1 (6.5)	177.8 (6.6)
Physical working capacity*	6.3 (1.8)	6.0 (1.8)	5.6 (1.8)	6.4 (1.8)	6.0 (1.8)	5.8 (1.8)
Systolic blood pressure*	127.7(11.1)	127.0(11.1)	128.1 (11.3)	127.7 (11.1)	127.3(11.0)	127.8 (11.4)
Diastolic blood pressure*	71.6 (8.6)	71.7 (8.6)	73.0 (9.0)	71.6 (8.6)	71.8 (8.8)	72.3 (8.8)
Cognitive function*	5.2 (2.0)	5.0 (2.0)	3.82 (2.1)	5.3 (1.9)	4.7 (2.0)	4.1 (2.0)
Total *(row percentages)*	*221 534 (93.2)*	*13 129 (5.5)*	*2944 (1.2)*	*201 507 (87.9)*	*16 983 (7.4)*	*10 683(4.7)*

Table 2. Unemployment in 1990 and mortality risk (1990-2001) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	846 / 43 637	1.78 (1.67-1.91)	Ref.	Ref.	Ref.	Ref.
Unemployed	198 / 3206	5.87 (5.10-6.74)	3.33 (2.85-3.89)	2.43 (2.06-2.88)	2.40 (1.99-2.90)	2.25 (1.83-2.75)
Cognitive score 4-6						
Employed	1655 / 117 393	1.30 (1.24-1.36)	Ref.	Ref.	Ref.	Ref.
Unemployed	281 / 6799	3.96 (3.52-4.45)	3.08 (2.72-3.50)	2.33 (2.04-2.67)	2.50 (2.15-2.90)	2.33 (1.98-2.74)
Cognitive score 7-9						
Employed	604 / 60 504	0.92 (0.85-1.00)	Ref.	Ref.	Ref.	Ref.
Unemployed	67 / 3124	2.13 (1.68-2.71)	2.33 (1.81-3.00)	1.85 (1.42-2.40)	1.80 (1.33-2.43)	1.53 (1.08-2.16)
EDUCATION						
Compulsory education						
Employed	1015/54 698	1.71 (1.60-1.81)	Ref.	Ref.	Ref.	Ref.
Unemployed	208/3634	5.47 (4.78-6.27)	3.25 (2.80-3.77)	2.35 (1.99-2.76)	2.31 (1.93-2.76)	2.23 (1.83-2.72)
≤ 3 years post-compulsory education						
Employed	1524/103 251	1.36 (1.29-1.43)	Ref.	Ref.		
Unemployed	291/6595	4.21 (3.76-4.73)	3.14 (2.77-3.56)	2.25 (1.97-2.58)	2.40 (2.06-2.80)	2.19 (1.86-2.58)
> 3 years post-compulsory education						
Employed	566/63 585	0.83 (0.76-0.90)	Ref.	Ref.	Ref.	Ref.
Unemployed	47/2900	1.61 (1.21-2-15)	1.98 (1.47-2.66)	1.90 (1.40-2.57)	1.87 (1.32-2.66)	1.67 (1.13-2.46)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

Table 3. Unemployment in 2001 and mortality risk (2001-2010) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	790 / 37 222	2.65 (2.47 -2.84)	Ref.	Ref.	Ref.	Ref.
Unemployed	328 / 5008	8.41 (7.55-9.38)	3.19 (2.80-3.63)	2.76 (2.41-3.17)	2.80 (2.42-3.24)	2.64 (2.22-3.15)
Cognitive score 4-6						
Employed	1751 / 107 598	2.03 (1.94-2.13)	Ref.	Ref.	Ref.	Ref.
Unemployed	500 / 8783	7.35 (6.74-8.03)	3.63 (3.29-4.01)	3.03 (2.73-3.37)	3.03 (2.71-3.40)	2.73 (2.36-3.15)
Cognitive score 7-9						
Employed	759 / 56 687	1.67 /1.56-1.80)	Ref.	Ref.	Ref.	Ref.
Unemployed	143 / 3192	5.83 (4.95-6.86)	3.49 (2.92-4.18)	2.85(2.36-3.45)	2.91 (2.38-3.56)	3.02 (2.37-3.85)
EDUCATION						
Compulsory education						
Employed	1000/48 367	2.58 (2.43-2.75)	Ref.	Ref.	Ref.	Ref.
Unemployed	332/5254	8.17 (7.34-9.10)	3.18 (2.81-3.60)	2.81 (2.47-3.21)	2.84 (2.47-3.27)	2.67 (2.25-3.18)
≤ 3 years post-compulsory education						
Employed	1615/93 225	2.16 (2.06-2.27)	Ref.	Ref.	Ref.	Ref.
Unemployed	533/9019	7.61 (6.99-8.29)	3.54 (3.21-3.90)	2.87 (2.58-3.19)	2.91 (2.60-3.25)	2.67 (2.32-3.07)
> 3 years post-compulsory education						
Employed	685/59 915	1.43 (1.33 – 1.54)	Ref.	Ref.	Ref.	Ref.
Unemployed	106/2710	5.07 (4.19-6.13)	3.54 (2.88-4.34)	3.44 (2.78-4.25)	3.37 (2.68-4.23)	3.43 (2.58-4.54)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	8, 15-16
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-8

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, explain how loss to follow-up was addressed	5-6, 8
		(*e*) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 9-11, 20
		(b) Give reasons for non-participation at each stage	5-6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5-6, 9-10, 20
		(b) Indicate number of participants with missing data for each variable of interest	6
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-11, 20-22
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-11, 21-22
		(*b*) Report category boundaries when continuous variables were categorized	6-8, 20-22
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11, 21-22
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-12

Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Mortality following unemployment during an economic downturn: Swedish register-based cohort study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003031.R1
Article Type:	Research
Date Submitted by the Author:	04-Jun-2013
Complete List of Authors:	Montgomery, Scott; Örebro University Hospital and Örebro University, Clinical Epidemiology and Biostatistics Udumyan, Ruzan; Örebro University Hospital, Clinical Epidemiology and Biostatistics Magnuson, Anders; Örebro University Hospital, Clinical Epidemiology and Biostatistics Osika, Walter; Karolinska Institute, Center for Social Sustainability, Dep of Neurobiology, Care Science and Society Sundin, Per-Ola; Örebro University Hospital, Department of Medicine Blane, David; Imperial College London, Department of Primary Care and Public Health
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Mental health, Public health
Keywords:	Unemployment, Suicide, Mortality

Mortality following unemployment during an economic downturn: Swedish register-based cohort study

Scott Montgomery,[1,2,3] Ruzan Udumyan,[1,2] Anders Magnuson, [1] Walter Osika, [4] Per-Ola Sundin,[2,5] David Blane[6]

1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85 Örebro, Sweden.
2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro, Sweden.
3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Insitutet, SE-171 76 Stockholm, Sweden.
4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
6. Department of Primary Care and Public Health, School of Public Health, Imperial College London W6 8RP, UK.

Correspondence: Professor Scott Montgomery
Clinical Epidemiology and Biostatistics
S-huset
Örebro University Hospital
701 85 Örebro
Sweden
Telephone +46 19 602 6210
scott.montgomery@orebroll.se

Word count: 296 (abstract); 3421 (text)

Acknowledgements: This study received support from Economic and Social Research Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to prepare the tables.

The study sponsors (ESRC and Örebro University) had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and clarified codes and measures required for the analysis. SM drafted the manuscript and all contributors were involved in critical editing. SM will act as guarantor.

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro University to support this work. None of the authors, their spouses, partners, or children have financial or non-financial relationships that may be relevant to the submitted work.

Data sharing: no additional data available, as the ethical permission does not allow for provision of data to individuals not in the research group.

ARTICLE SUMMARY

Article focus

- Unemployment is associated with poor health and excess mortality, which is explained by a variety of mechanisms.
- Higher qualifications and better cognitive function are associated with better health.
- Economic adversity has been associated with disproportionate damage to health among individuals who were previously advantaged, so unemployment may have this effect among those with higher qualifications and better cognitive function.

Key messages

- Unemployment in later working life is more likely to be associated with damage to heath among those with better cognitive function and qualifications than unemployment at a younger age.
- This emphasises the importance of supporting all older workers who become unemployed, including those with characteristics usually associated with better health.

Strengths and limitations of this study

- The study benefits from use of a large longitudinal cohort with prospectively recorded information.

- Unemployment is only measured at limited number of time points, so the study cannot examine duration of exposure.

- The use of Swedish military conscription data limited the study to men, so it is not known if findings would be similar among women.

ABSTRACT

Objective

To investigate if unemployment during an economic downturn is associated with mortality, even among men with markers of better health (higher cognitive function scores and qualifications), and to assess whether the associations vary by age at unemployment.

Design and Setting National longitudinal cohort study using Swedish register data. The follow-up periods (1990-2001 and 2001-2010) were chosen as Sweden entered periods of significant economic contraction in 1990 and 2001.

Participants A representative sample of men from the general population (n=234,782) born between 1952 and 1956 who participated in military conscription examinations.

Main outcome measure All-cause mortality.

Results Unemployment compared with employment in 1991 (ages 34 to 38 years) produced adjusted hazard ratios (with 95% confidence intervals) for all-cause mortality (3651 deaths) during follow-up to 2001 and after stratification by education of 2.35

(1.99 to 2.76) for compulsory education, 2.25 (1.97 to 2.58) for up to three years post-compulsory education and 1.90 (1.40 to 2.57) for more than three years post-compulsory education. When unemployment was compared with employment in 2001 (ages 45 to 49 years) with follow-up to 2010, the pattern of mortality risk (4271 deaths) stratified by education was reversed, producing adjusted hazard ratios of 2.81 (2.47 to 3.21) for compulsory education, 2.87 (2.58 to 3.19) for up to three years post-compulsory education and 3.44 (2.78 to 4.25) for more than three years post-compulsory education. Interaction testing confirmed effect modification by age/period (p=0.003). The degree of gradient reversal was slightly less pronounced after stratification by cognitive function but produced a similar pattern of results (p =0.004).

Conclusions Unemployment at older ages is associated with greater mortality risk than at younger ages, with the greatest relative increase in risk among men with markers of better health, suggesting the greater vulnerability of all older workers to unemployment-associated exposures.

Introduction

Economic recession and associated austerity measures result in increased unemployment, which is linked with poorer health and excess mortality through a variety of mechanisms.[1] During a recession, unemployment may be experienced by a broader spectrum of the working population rather than just more disadvantaged individuals. Does this atypical pattern of exposure to unemployment have unexpected health consequences?

Better cognitive function and higher levels of education are associated with better health and reduced mortality risk in later life.[2-4] A review of intelligence in youth and all-cause mortality highlighted the likely importance of economic and social characteristics in adulthood in explaining the association.[3] Further clarification may be gained by examining how economic disadvantage such as unemployment modifies the association of intelligence in adolescence with adult mortality risk.

Better cognitive function and educational attainment confer protection against unemployment and facilitate a more rapid transition back to employment from unemployment, thus reducing the duration of exposure to unemployment-associated adversity. Therefore, health following experience of unemployment should be better among those with better cognitive function and the more highly qualified. However, in earlier studies we demonstrated that *unexpected* financial adversity is disproportionately damaging to health,[5-7] where adult economic disadvantage was experienced among those with pre-existing markers of better health and economic potential signalled by markers of childhood advantage. The disappointment paradox[7] hypothesises that when individuals with greater potential and expectations encounter economic adversity in adulthood the experience is relatively unexpected, resulting in higher levels of stress and depression and thus also damage to other aspects of health. This is consistent with the finding that psychological distress associated with unemployment was reported more frequently reported among white-collar than blue-collar workers.[8]

Unexpected economic adversity even among those with greater personal resources may be a particularly damaging at *older* ages,[9] and obtaining another job at an equivalent

level more difficult. As the mechanisms linking cognitive function and education with mortality may not be identical,[2] we examined these measures separately. This study uses Swedish register data to examine associations of unemployment with mortality among a cohort of men born between 1952 and 1956, to test the hypothesis that unemployment disproportionately eliminates health potential associated with better cognitive function and higher qualifications and that the effect varies by age. Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic recession and another period of significant economic contraction was beginning in 2001.

Methods

Study population

The cohort comprised all men born between 1st January 1952 and 31st December 1956 that were included in the Swedish Military Conscription Register.[10 11] At this time the majority of male Swedish citizens participated in the assessment for compulsory military service that took place in late adolescence and fewer than 4% of men were not involved due to chronic illness or disability. The assessments were between 1970 and 1975 and the majority at ages 18 and 19 years, with a small number after this time at later ages. A total of 284,198 men were identified and 2,564 were excluded due to data inconsistencies such as errors in the personal identification number, female sex or uncertain vital status. We then excluded 225 men from the analysis with improbable measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This resulted in a sample of 272,768 men with data at the start of follow-up in December

1990. We then excluded 35,161 men with missing data for: census (18,178); education (2,440); or the conscription assessments (28,483) that may have resulted from loss of records. The sample available for the main analysis comprised 234,782 men.

Measures

The conscription examination in late adolescence provided the following measures. Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic blood pressure were measured after rest in recumbent men using a sphygmomanometer. Physical working capacity was assessed using an electronically braked ergonometer for the maximum load sustained for six minutes, or an estimate was derived from a nomogram for shorter duration. Cognitive testing covered four domains: linguistic understanding (40 questions), spatial recognition (identifying geometric shapes), general knowledge (40 questions) and ability to follow mechanical instructions (problems presented as diagrams requiring knowledge of mechanics and basic physics). The results of the cognitive function tests were transformed into a single score with a value on a normalized standard scale ranging from 1 to 9. The conscripts underwent a psychological examination to assess their potential ability to cope with warfare and therefore providing an indication of their stress resilience, producing a score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in Swedish,[12] but it has been used in research reported in English.[13] The medical assessment produced a score of 0 to 9 to indicate the severity of any medical problems, such that 9 indicated no problem, with a decreasing score indicating increasing severity to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-defined problem (n=22).

Statistics Sweden provided socioeconomic and demographic data using the registers they administer,[14] including information on vital status and emigration from the Total Population register. Childhood social and material circumstances were estimated using data from the 1960 census, where the head of the household's occupation was characterised as manual, agricultural, farm owners/managers, office workers, business owners/managers, and others. The person per room ratio was divided into quarters of its distribution. The Longitudinal database of Education, Income, and Occupation (LISA) was used to obtain information on level of attained education in 1990, employment status in 1985, as well employment status and receipt of disability/chronic disease benefits in 1990 and 2001. Attained education – based on the duration of education required for the qualification - was divided into three categories: compulsory (up to nine years); up to three years post-compulsory; and over three years post-compulsory. Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of disability/chronic disease benefits at any time earlier in the year was recorded.

The Cause of Death Register[15] provided ICD codes on causes of death, including for suicide, where we also included undetermined intent as possible suicide.

Statistical analysis

Cox regression was used to examine the association of unemployment (compared with employment) with subsequent mortality risk over two periods: unemployment in 1990 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who received disability/chronic disease benefits at entry to either follow-up period were excluded from analysis in that period. Follow-up was to death, emigration or the end of the study period, whichever occurred first. The analysis was adjusted for socioeconomic

index of parents and household crowding in 1960, and the following conscription measures: BMI in categories as in table 1, height (continuous), physical working capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8, and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the later follow-up period) and region of residence. Attained age was used as the underlying time-scale for all models to achieve the most efficient adjustment for age. The analyses were stratified by the cognitive function score divided into equal thirds of its distribution and then by the three-category education variable. Further analyses excluded mortality due to suicide (including where the cause of death was recorded as undetermined intent). Analyses then excluded the first four years of follow-up after 1990 and 2001 to allow for 'selection to wear off'.[16 17]

A Cox regression model with follow-up over the entire study period (1990 to 2010) assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for the association with mortality for the combination of unemployment with cognitive function or with education. Unemployment was modelled as a time-dependent covariate and the analysis was adjusted for the potential confounding factors described above.

The statistical software used was Stata version 12/SE for Windows (StataCorp, College Station, Texas). Tests were 2-sided and statistical significance was defined as $p<0.05$ and 95% confidence intervals that do not include 1.00.

Ethical permission

Ethical permission to conduct this project was granted by the Uppsala Regional Ethics Committee (Dnr 2009/306).

Results

All of the characteristics investigated were statistically significantly associated with unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than 0.001, p values are not presented. Unemployment and receipt of a disability pension in both periods were associated with lower parental SEI, greater household crowding, BMI indicating underweight or obesity, diagnoses of more severe diseases at conscription, low stress resilience, lower level qualifications, shorter stature, lower physical working capacity, and lower cognitive function score. Higher diastolic blood pressure was associated with unemployment and disability pension, but the pattern is more complex for systolic blood pressure. The total number unemployed in 2001 was greater than in 1990 and the number on disability/chronic sickness benefit was notably greater in 2001. Overall, the distribution of educational attainment and cognitive function score among the employed was very similar between the two periods, but a higher proportion of those who experienced unemployment during the second period had lower qualifications and cognitive function scores.

During the period 1990 to 2001, unemployment compared with employment in 1990 was associated with a statistically significantly raised risk of mortality in each of the cognitive function and education strata, both before and after adjustment for the potential confounding factors (table 2). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. The results are graded by cognition and education, with the highest unemployment-related

mortality risk among men with the lowest cognitive function scores and education. Exclusion of deaths due to suicide altered the gradient of risk between the first two strata, but men with the highest cognitive function scores and qualifications remained at lowest risk of mortality if they experienced unemployment. Some reduction in magnitude of risk, but without loss of statistical significance, was observed when deaths during the first four years of follow-up were excluded to allow for the 'wearing off' of direct health selection.

During the period 2001 to 2010, unemployment compared with employment in 2001 was associated with a statistically significantly raised risk of mortality in each of the education strata both before and after adjustment for the potential confounding factors (table 3). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. In contrast with the earlier period, the unemployment-related mortality risk, when stratified by cognition or education, is reversed and consistently higher for the strata of those with the highest levels of cognitive function or education. It is noteworthy that the absolute rate of unemployment-related mortality is much more similar across the cognition and education strata; even though there is more of a gradient among the employed. In all of the adjusted models, after exclusion of death by suicide, and after allowing 'selection to wear off', the gradient of unemployment-related mortality remains reversed or eliminated compared with the earlier period: those with the higher level cognitive function scores and qualifications had higher hazard ratios for mortality associated with unemployment.

The interaction tests to assess effect modification by age/period are statistically significant for both cognitive function (p=0.004) and education (p=0.003), consistent with higher mortality among in men with better cognitive function or education when they experience unemployment at a later age.

Discussion

Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was associated with all-cause mortality: men with poorer cognitive function test scores and lower-level educational attainment were at greater relative risk (measured by hazard ratios) than men with higher qualifications. Unemployment in 2001 when the men were aged 45 to 49 years was also associated with subsequent mortality, but the gradient was reversed, such that the more intelligent and more highly qualified men were at greater relative risk of mortality following unemployment. The gradient of absolute unemployment-associated mortality rate, across cognition and education strata was attenuated substantially by unemployment at an older age in 2001.

Previous research using data from the USA found that low income was a greater relative risk for ischaemic heart disease and depression among individuals with markers of a relatively privileged childhood and higher qualifications.[5 7] Data from older adults in Britain revealed that similar economic adversity eliminated the lower depression risk associated with markers of earlier advantage.[6] We hypothesised that this *unexpected* adversity results in a form of disappointment, thus increasing the risk of disease through behavioural change and the systemic consequences of stress. This study is an extension of the disappointment paradox concept but using longitudinal rather than cross-sectional data. Unemployment at an older age among the more highly qualified and

those with higher cognitive function scores may represent a stressful exposure that is more unexpected or more difficult to cope with than unemployment experienced among men with fewer qualifications or lower cognitive function scores, as suggested by the higher levels of unemployment-related psychological distress observed among white-collar workers.[8] As we are concerned with unemployment as marker of socioeconomic adversity we did not adjust for other contemporaneous economic measures collinear with unemployment. The earlier research used diagnoses as the outcome[5-7] and the results could theoretically have been influenced by more highly educated individuals seeking health care: the use of mortality in this study is not at similar risk of bias through health service use.

It has long been observed that suicide rates increase both during periods of economic recession and also during phases of rapid economic growth; arguing that weakened social norms, rather than poverty alone, reduces social cohesion and thus increases suicide risk.[18] A sense of coherence is relevant to an individual's adaptive capacity for social stress[19] and unemployment may be damaging in this respect. Those with higher cognitive function and qualifications, signalling more advantages in earlier life, may be less well adapted to coping with unemployment-related stress.[6 7] This theoretical framework not only potentially explains associations with suicide (the risk of which can vary by age[20]), as our results are similar after exclusion of suicide. Poorer adaptation to social adversity has also been linked to increased risk of stroke,[21] indicating effects on the cardiovascular and possibly other systems.

Interaction analysis confirmed that the pattern of risk changed between the periods such that the greater risk of mortality among men with better cognition and

qualifications who experienced unemployment at an older age was disproportionately higher (a multiplicative effect). Older people who have less possibility to return to work may find the consequence of the associated economic adversity more challenging,[9] particularly during a period of economic contraction, despite the resources signalled by higher cognition and qualifications. This unemployment-associated risk of ill health may continue to increase with age.

Health selection can help to explain associations between unemployment and disease.[22] Direct health selection is where pre-existing illness increases the risk of unemployment. We tackled this by excluding men with disability and sickness benefits at study entry and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we excluded events (deaths) in the initial years of follow-up after unemployment to allow selection to 'wear off' when a high proportion of those with the most serious diseases pre-dating unemployment are expected to die,[16] as used in other studies of unemployment and mortality, including a previous study of unemployment in Sweden.[17] The earlier Swedish study presented evidence of direct health selection as there was statistically significant excess mortality in the first four years following unemployment but not subsequently.[17] Therefore we excluded the first four years of the follow-up in a sub-analysis. Even though the men who experienced unemployment in the second period of our study may have been more selected in terms of health, our procedures to tackle direct selection make this unlikely as an explanation for the reversal of the unemployment-mortality gradient by cognition or education.

Indirect health selection is where personal characteristics linked with raised unemployment risk are also risks for poor health.[22 23] We adjusted for a variety of

measures relevant to future health and mortality risk, including chronic illnesses, height,[24] blood pressure,[10] BMI,[25 26] cognition,[2 3] markers of physical fitness[26] and stress resilience. Men with the most severe disabilities or chronic illness preventing military service would not have undergone some of the tests at conscription and are thus not included in the analysis. Indirect health selection is unlikely to explain the disappearance at a later age of the relatively protective association with higher qualifications and cognition, as the opposite effect might be expected.

It should be emphasised that unemployment remained less common among the more highly educated men and those with higher cognitive function. This means that support and benefits will remain a bigger issue for the less highly qualified and more disadvantaged. Unemployment can result in persistent disadvantage, including through subsequent unstable employment,[27-29] so when experienced at an earlier age it can cause harm across an entire adult life. While it remains possible that earlier exit from the labour market helps to explain these results, it does not alter the fact that unemployment among older men is relatively more damaging across the social spectrum, suggesting this is a 'critical period' where interventions might be focused.[30]

The experience of unemployment can contribute to the risk of ill-health through several mechanisms.[1] Behavioural change following unemployment, such as increases in smoking (or failure to give up) and an unhealthy diet[27] can increase the risk of cardiovascular disease and cancer. The financial disadvantage associated with unemployment can persist even after finding a new job[27] and the association of poverty with mortality is well known.[31] Depression and stress resulting from unemployment is also likely to be relevant, as this has may raise mortality risk through behavioural and

possibly systemic mechanisms.[32] Stressful events and circumstances have been linked to an increase in mortality due to suicide and cardiovascular disease.[33] The mechanisms linking cognitive function and education with mortality may not be identical,[2] but the pattern of unemployment-related mortality risk is similar when stratified by cognition or education.

Limitations

Potential limitations of the study include its inclusion of only men, as women can also be affected adversely by unemployment. This was necessary as the detailed baseline data on health and function were collected during military conscription, which at the time was only available to men. Disentangling age and period effects in a single cohort can be problematic. The two time points differed in unemployment rate: the proportion unemployed was larger in the second period, thus possibly altering selection effects. To tackle possible selection bias we adjusted for multiple markers of susceptibility. We also excluded events during the first part of the follow-up period to allow direct health selection to 'wear off'. The study focused on unemployment only at two time points and these represent times when Sweden was entering periods of economic contraction: these were chosen when the study was designed and information on unemployment at other times was not included in our dataset. These measures will underestimate the experience of unemployment and does not take duration of unemployment into account. This is likely to make our estimates less precise rather than creating spurious results. There is a greater possibility of prior unemployment in the later period and thus greater unemployment duration, but our adjustment for previous unemployment did not indicate that this was driving the results. The focus of the study was on mortality as an objective endpoint. While this will underestimate the damage to health associated with

unemployment substantially, it makes it more feasible to tackle the effects of direct health selection, as less serious health events that could influence unemployment risk will not contribute so notably to mortality in the first years following unemployment that we excluded from the 'selection wearing off' analysis. Mortality is more likely to occur at older ages and causes of mortality vary by age.

Unemployment during periods of economic contraction is associated with raised mortality that may not be explained fully by direct or indirect health selection into unemployment. With increasing age, the experience of unemployment may be unexpectedly harmful to those with better cognition, higher qualifications and associated resources. This highlights the importance of supporting the entire population who experience unemployment during a recession and the greater vulnerability of older workers.

1. Janlert U, Hammarstrom A. Which theory is best? Explanatory models of the relationship between unemployment and health. *BMC public health* 2009;9:235.
2. Lager A, Bremberg S, Vagero D. The association of early IQ and education with mortality: 65 year longitudinal study in Malmo, Sweden. *Bmj* 2009;339:b5282.
3. Calvin CM, Deary IJ, Fenton C, et al. Intelligence in youth and all-cause-mortality: systematic review with meta-analysis. *International journal of epidemiology* 2011;40(3):626-44.
4. Batty GD, Wennerstad KM, Smith GD, et al. IQ in early adulthood and mortality by middle age: cohort study of 1 million Swedish men. *Epidemiology* 2009;20(1):100-9.
5. Osika W, Ehlin A, Montgomery SM. Does height modify the risk of angina associated with economic adversity? *Economics and human biology* 2006;4(3):398-411.
6. Montgomery SM, Netuveli G, Hildon Z, et al. Does financial disadvantage at older ages eliminate the potential for better health? *Journal of epidemiology and community health* 2007;61(10):891-5.
7. Osika W, Montgomery SM. Economic disadvantage modifies the association of height with low mood in the US, 2004: the disappointment paradox. *Economics and human biology* 2008;6(1):95-107.
8. D'Arcy C, Siddique CM. Unemployment and health: an analysis of "Canada Health Survey" data. *International journal of health services : planning, administration, evaluation* 1985;15(4):609-35.
9. McKee M, Stuckler D. Older people in the UK: under attack from all directions. *Age and ageing* 2013;42(1):11-3.
10. Sundstrom J, Neovius M, Tynelius P, et al. Association of blood pressure in late adolescence with subsequent mortality: cohort study of Swedish male conscripts. *Bmj* 2011;342:d643.
11. Whitley E, Batty GD, Gale CR, et al. Intelligence in early adulthood and subsequent risk of unintentional injury over two decades: cohort study of 1 109 475 Swedish men. *Journal of epidemiology and community health* 2010;64(5):419-25.
12. Lothigius J. *Verksamhetsinstruktion för Psykologer VIP95 (Psychological Test Manual used by the Swedish National Service Administration VIP95)*. Karlstad, 1995.
13. Nilsson PM, Nyberg P, Ostergren PO. Increased susceptibility to stress at a psychological assessment of stress tolerance is associated with impaired fetal growth. *International journal of epidemiology* 2001;30(1):75-80.
14. Statistics Sweden. http://www.scb.se/default___2154.aspx, (accessed 25 March 2013).
15. The Cause of Death Register. http://www.socialstyrelsen.se/register/dodsorsaksregistret, (accessed 25 March 2013).
16. Moser KA, Goldblatt PO, Fox AJ, et al. Unemployment and mortality: comparison of the 1971 and 1981 longitudinal study census samples. *British medical journal* 1987;294(6564):86-90.
17. Lundin A, Lundberg I, Hallsten L, et al. Unemployment and mortality--a longitudinal prospective study on selection and causation in 49321 Swedish middle-aged men. *Journal of epidemiology and community health* 2010;64(1):22-8.
18. Durkheim É. *Suicide: a study in sociology; translated by John A Spaulding and George Simpson*. New York: The Free Press of Glencoe, 1951.

19. Surtees PG, Wainwright NW, Khaw KT. Resilience, misfortune, and mortality: evidence that sense of coherence is a marker of social stress adaptive capacity. *Journal of psychosomatic research* 2006;61(2):221-7.
20. Varnik P. Suicide in the world. *International journal of environmental research and public health* 2012;9(3):760-71.
21. Surtees PG, Wainwright NW, Luben RL, et al. Adaptation to social adversity is associated with stroke incidence: evidence from the EPIC-Norfolk prospective cohort study. *Stroke; a journal of cerebral circulation* 2007;38(5):1447-53.
22. Bartley M, Ferrie J. Do we need to worry about the health effects of unemployment? *Journal of epidemiology and community health* 2010;64(1):5-6.
23. Montgomery SM, Bartley MJ, Cook DG, et al. Health and social precursors of unemployment in young men in Great Britain. *Journal of epidemiology and community health* 1996;50(4):415-22.
24. Magnusson PK, Gunnell D, Tynelius P, et al. Strong inverse association between height and suicide in a large cohort of Swedish men: evidence of early life origins of suicidal behavior? *The American journal of psychiatry* 2005;162(7):1373-5.
25. Magnusson PK, Rasmussen F, Lawlor DA, et al. Association of body mass index with suicide mortality: a prospective cohort study of more than one million men. *American journal of epidemiology* 2006;163(1):1-8.
26. Bellocco R, Jia C, Ye W, et al. Effects of physical activity, body mass index, waist-to-hip ratio and waist circumference on total mortality risk in the Swedish National March Cohort. *European journal of epidemiology* 2010;25(11):777-88.
27. Wadsworth ME, Montgomery SM, Bartley MJ. The persisting effect of unemployment on health and social well-being in men early in working life. *Social science & medicine* 1999;48(10):1491-9.
28. Virtanen P, Vahtera J, Kivimaki M, et al. Employment security and health. *Journal of epidemiology and community health* 2002;56(8):569-74.
29. Ferrie JE, Shipley MJ, Stansfeld SA, et al. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *Journal of epidemiology and community health* 2002;56(6):450-4.
30. Bartley M, Blane D, Montgomery S. Health and the life course: why safety nets matter. *Bmj* 1997;314(7088):1194-6.
31. Thomas B, Dorling D, Smith GD. Inequalities in premature mortality in Britain: observational study from 1921 to 2007. *Bmj* 2010;341:c3639.
32. Cohen F, Kemeny ME, Zegans LS, et al. Immune function declines with unemployment and recovers after stressor termination. *Psychosomatic medicine* 2007;69(3):225-34.
33. Fang F, Fall K, Mittleman MA, et al. Suicide and cardiovascular death after a cancer diagnosis. *The New England journal of medicine* 2012;366(14):1310-8.

Table 1. Population characteristics and subsequent unemployment in 1990 and 2001

	1990			2001		
	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)
Parental SEI 1960						
Manual workers	91 878 (41.5)	5274 (40.2)	1380 (46.9)	82 938 (41.2)	7413 (43.6)	5049 (47.3)
Agricultural workers	8592 (3.9)	471 (3.6)	120 (4.1)	7693 (3.8)	743 (4.4)	507 (4.7)
Farm owners/managers	22 510 (10.2)	948 (7.2)	206 (7.0)	20 931 (10.4)	1373 (8.1)	770 (7.2)
Office workers	61 748 (27.9)	3774 (28.7)	684 (23.2)	56 698 (28.1)	4199 (24.7)	2389 (22.4)
Business owners/managers	23 701 (10.7)	1569 (12.0)	263 (8.9)	21 690 (10.8)	1893 (11.1)	982 (9.2)
Others/unknown	13105 (5.9)	1093 (8.3)	291 (9.9)	11 557 (5.7)	1362 (8.0)	986 (9.2)
Household crowding, 1960						
≤2 people/ room	173 804 (78.5)	9883 (75.3)	2085 (70.8)	159 131 (79.0)	12 412 (73.1)	7538 (70.6)
> 2 people/ room	47 730 (21.5)	3246 (24.7)	859 (29.2)	42 376 (21.0)	4562 (26.9)	3145 (29.4)
BMI categories, kg/m²						
Underweight (<18.5)	25 476 (11.5)	1664 (12.7)	481 (16.3)	22 999 (11.4)	2106 (12.4)	1525 (14.3)
Normal weight (18.5, <25)	179 381 (81.0)	10 456 (79.6)	2234 (75.9)	163 723 (81.2)	13 451 (79.2)	8142 (76.2)
Overweight (25.0, <30)	14536 (6.6)	833 (6.3)	183 (6.2)	12 955 (6.4)	1191 (7.0)	837 (7.8)
Obese (≥30.0)	2141 (1.0)	176 (1.3)	46 (1.6)	1839 (0.9)	235 (1.4)	179 (1.7)
Summary disease score						
Very significant problem (0)	10 560 (4.8)	1613 (12.3)	897 (30.5)	8212 (4.1)	1920 (11.3)	2159 (20.2)
Significant problem (2-3)	6468 (2.9)	586 (4.5)	249 (8.5)	5481 (2.7)	782 (4.6)	698 (6.5)
Fairly significant (4-5)	16671 (7.5)	1061 (8.1)	246 (8.4)	14 782 (7.3)	1548 (9.1)	1032 (9.7)
No serious problem (6-8)	88 816 (40.1)	4832 (36.8)	830 (28.2)	81 106 (40.2)	6472 (38.1)	3774 (35.3)
No diagnosis (9)	98 997 (44.7)	5037 (38.4)	722 (24.5)	91 909 (45.6)	6260 (36.9)	3018 /28.3)
Ill-defined problem (1)	22 (0.0)	0 (0.0)	0 (0.0)	18 (0.0)	1 (0.0)	2 (0.0)
Stress resilience						
Low (1-3)	45 221 (20.4)	4407 (33.6)	1750 (59.4)	38 222 (19.0)	5927 (34.9)	5108 (47.8)
Moderate (4-6)	122 546 (55.3)	6092 (46.4)	1005 (34.1)	112 943 (56.0)	8227 (48.4)	4494 (42.1)
High (7-9)	53 767 (24.3)	2630 (20.0)	189 (6.4)	50 342 (25.0)	2829 (16.7)	1081 (10.1)
Education						
Compulsory	54 698 (24.7)	3634 (27.7)	1345 (45.7)	48 367 (24.0)	5254 (30.9)	4089 (38.3)
≤ 3 years post-compulsory	103 251 (46.6)	6595 (50.2)	1388 (47.1)	93 225 (46.3)	9019 (53.1)	5577 (52.2)
> 3 years post-compulsory	63 585 (28.7)	2900 (22.1)	211 (7.2)	59 915 (29.7)	2710 (16.0)	1017 (9.5)
Height*	178.7 (6.4)	178.4 (6.5)	177.7 (6.7)	178.8 (6.4)	178.1 (6.5)	177.8 (6.6)
Physical working capacity*	6.3 (1.8)	6.0 (1.8)	5.6 (1.8)	6.4 (1.8)	6.0 (1.8)	5.8 (1.8)
Systolic blood pressure*	127.7(11.1)	127.0(11.1)	128.1 (11.3)	127.7 (11.1)	127.3(11.0)	127.8 (11.4)
Diastolic blood pressure*	71.6 (8.6)	71.7 (8.6)	73.0 (9.0)	71.6 (8.6)	71.8 (8.8)	72.3 (8.8)
Cognitive function*	5.2 (2.0)	5.0 (2.0)	3.82 (2.1)	5.3 (1.9)	4.7 (2.0)	4.1 (2.0)
Total *(row percentages)*	*221 534 (93.2)*	*13 129 (5.5)*	*2944 (1.2)*	*201 507 (87.9)*	*16 983 (7.4)*	*10 683(4.7)*

Table 2. Unemployment in 1990 and mortality risk (1990-2001) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	846 / 43 637	1.78 (1.67-1.91)	Ref.	Ref.	Ref.	Ref.
Unemployed	198 / 3206	5.87 (5.10-6.74)	3.33 (2.85-3.89)	2.43 (2.06-2.88)	2.40 (1.99-2.90)	2.25 (1.83-2.75)
Cognitive score 4-6						
Employed	1655 / 117 393	1.30 (1.24-1.36)	Ref.	Ref.	Ref.	Ref.
Unemployed	281 / 6799	3.96 (3.52-4.45)	3.08 (2.72-3.50)	2.33 (2.04-2.67)	2.50 (2.15-2.90)	2.33 (1.98-2.74)
Cognitive score 7-9						
Employed	604 / 60 504	0.92 (0.85-1.00)	Ref.	Ref.	Ref.	Ref.
Unemployed	67 / 3124	2.13 (1.68-2.71)	2.33 (1.81-3.00)	1.85 (1.42-2.40)	1.80 (1.33-2.43)	1.53 (1.08-2.16)
EDUCATION						
Compulsory education						
Employed	1015/54 698	1.71 (1.60-1.81)	Ref.	Ref.	Ref.	Ref.
Unemployed	208/3634	5.47 (4.78-6.27)	3.25 (2.80-3.77)	2.35 (1.99-2.76)	2.31 (1.93-2.76)	2.23 (1.83-2.72)
≤ 3 years post-compulsory education						
Employed	1524/103 251	1.36 (1.29-1.43)	Ref.	Ref.		
Unemployed	291/6595	4.21 (3.76-4.73)	3.14 (2.77-3.56)	2.25 (1.97-2.58)	2.40 (2.06-2.80)	2.19 (1.86-2.58)
> 3 years post-compulsory education						
Employed	566/63 585	0.83 (0.76-0.90)	Ref.	Ref.	Ref.	Ref.
Unemployed	47/2900	1.61 (1.21-2-15)	1.98 (1.47-2.66)	1.90 (1.40-2.57)	1.87 (1.32-2.66)	1.67 (1.13-2.46)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

Table 3. Unemployment in 2001 and mortality risk (2001-2010) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	790 / 37 222	2.65 (2.47 -2.84)	Ref.	Ref.	Ref.	Ref.
Unemployed	328 / 5008	8.41 (7.55-9.38)	3.19 (2.80-3.63)	2.76 (2.41-3.17)	2.80 (2.42-3.24)	2.64 (2.22-3.15)
Cognitive score 4-6						
Employed	1751 / 107 598	2.03 (1.94-2.13)	Ref.	Ref.	Ref.	Ref.
Unemployed	500 / 8783	7.35 (6.74-8.03)	3.63 (3.29-4.01)	3.03 (2.73-3.37)	3.03 (2.71-3.40)	2.73 (2.36-3.15)
Cognitive score 7-9						
Employed	759 / 56 687	1.67 /1.56-1.80)	Ref.	Ref.	Ref.	Ref.
Unemployed	143 / 3192	5.83 (4.95-6.86)	3.49 (2.92-4.18)	2.85(2.36-3.45)	2.91 (2.38-3.56)	3.02 (2.37-3.85)
EDUCATION						
Compulsory education						
Employed	1000/48 367	2.58 (2.43-2.75)	Ref.	Ref.	Ref.	Ref.
Unemployed	332/5254	8.17 (7.34-9.10)	3.18 (2.81-3.60)	2.81 (2.47-3.21)	2.84 (2.47-3.27)	2.67 (2.25-3.18)
≤ 3 years post-compulsory education						
Employed	1615/93 225	2.16 (2.06-2.27)	Ref.	Ref.	Ref.	Ref.
Unemployed	533/9019	7.61 (6.99-8.29)	3.54 (3.21-3.90)	2.87 (2.58-3.19)	2.91 (2.60-3.25)	2.67 (2.32-3.07)
> 3 years post-compulsory education						
Employed	685/59 915	1.43 (1.33 – 1.54)	Ref.	Ref.	Ref.	Ref.
Unemployed	106/2710	5.07 (4.19-6.13)	3.54 (2.88-4.34)	3.44 (2.78-4.25)	3.37 (2.68-4.23)	3.43 (2.58-4.54)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

Mortality following unemployment during an economic downturn: Swedish register-based cohort study

Scott Montgomery,[1,2,3] Ruzan Udumyan,[1,2] Anders Magnuson, [1] Walter Osika, [4] Per-Ola Sundin,[2,5] David Blane[6]

1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85 Örebro, Sweden.
2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro, Sweden.
3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Insitutet, SE-171 76 Stockholm, Sweden.
4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
6. Department of Primary Care and Public Health, School of Public Health, Imperial College London W6 8RP, UK.

Correspondence: Professor Scott Montgomery
Clinical Epidemiology and Biostatistics
S-huset
Örebro University Hospital
701 85 Örebro
Sweden
Telephone +46 19 602 6210
scott.montgomery@orebroll.se

Word count: 296 (abstract); 3421 (text)

Acknowledgements: This study received support from Economic and Social Research Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to prepare the tables.

The study sponsors (ESRC and Örebro University) had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and clarified codes and measures required for the analysis. SM drafted the manuscript and all contributors were involved in critical editing. SM will act as guarantor.

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro University to support this work. None of the authors, their spouses, partners, or children have financial or non-financial relationships that may be relevant to the submitted work.

Data sharing: no additional data available, as the ethical permission does not allow for provision of data to individuals not in the research group.

ARTICLE SUMMARY

Article focus

- Unemployment is associated with poor health and excess mortality, which is explained by a variety of mechanisms.
- Higher qualifications and better cognitive function are associated with better health.
- Economic adversity has been associated with disproportionate damage to health among individuals who were previously advantaged, so unemployment may have this effect among those with higher qualifications and better cognitive function.

Key messages

- Unemployment in later working life is more likely to be associated with damage to heath among those with better cognitive function and qualifications than unemployment at a younger age.
- This emphasises the importance of supporting all older workers who become unemployed, including those with characteristics usually associated with better health.

Strengths and limitations of this study

- The study benefits from use of a large longitudinal cohort with prospectively recorded information.

- Unemployment is only measured at limited number of time points, so the study cannot examine duration of exposure.

- The use of Swedish military conscription data limited the study to men, so it is not known if findings would be similar among women.

ABSTRACT

Objective

To investigate if unemployment during an economic downturn is associated with mortality, even among men with markers of better health (higher cognitive function scores and qualifications), and to assess whether the associations vary by age at unemployment.

Design and Setting National longitudinal cohort study using Swedish register data. The follow-up periods (1990-2001 and 2001-2010) were chosen as Sweden entered periods of significant economic contraction in 1990 and 2001.

Participants A representative sample of men from the general population (n=234,782) born between 1952 and 1956 who participated in military conscription examinations.

Main outcome measure All-cause mortality.

Results Unemployment compared with employment in 1991 (ages 34 to 38 years) produced adjusted hazard ratios (with 95% confidence intervals) for all-cause mortality (3651 deaths) during follow-up to 2001 and after stratification by education of 2.35

(1.99 to 2.76) for compulsory education, 2.25 (1.97 to 2.58) for up to three years post-compulsory education and 1.90 (1.40 to 2.57) for more than three years post-compulsory education. When unemployment was compared with employment in 2001 (ages 45 to 49 years) with follow-up to 2010, the pattern of mortality risk (4271 deaths) stratified by education was reversed, producing adjusted hazard ratios of 2.81 (2.47 to 3.21) for compulsory education, 2.87 (2.58 to 3.19) for up to three years post-compulsory education and 3.44 (2.78 to 4.25) for more than three years post-compulsory education. Interaction testing confirmed effect modification by age/period (p=0.003). The degree of gradient reversal was slightly less pronounced after stratification by cognitive function but produced a similar pattern of results (p =0.004).

Conclusions Unemployment at older ages is associated with greater mortality risk than at younger ages, with the greatest relative increase in risk among men with markers of better health, suggesting the greater vulnerability of all older workers to unemployment-associated exposures.

Introduction

Economic recession and associated austerity measures result in increased unemployment, which is linked with poorer health and excess mortality through a variety of mechanisms.[1] During a recession, unemployment may be experienced by a broader spectrum of the working population rather than just more disadvantaged individuals. Does this atypical pattern of exposure to unemployment have unexpected health consequences?

Better cognitive function and higher levels of education are associated with better health and reduced mortality risk in later life.[2-4] A review of intelligence in youth and all-cause mortality highlighted the likely importance of economic and social characteristics in adulthood in explaining the association.[3] Further clarification may be gained by examining how economic disadvantage such as unemployment modifies the association of intelligence in adolescence with adult mortality risk.

Better cognitive function and educational attainment confer protection against unemployment and facilitate a more rapid transition back to employment from unemployment, thus reducing the duration of exposure to unemployment-associated adversity. Therefore, health following experience of unemployment should be better among those with better cognitive function and the more highly qualified. However, in earlier studies we demonstrated that *unexpected* financial adversity is disproportionately damaging to health,[5-7] where adult economic disadvantage was experienced among those with pre-existing markers of better health and economic potential signalled by markers of childhood advantage. The disappointment paradox[7] hypothesises that when individuals with greater potential and expectations encounter economic adversity in adulthood the experience is relatively unexpected, resulting in higher levels of stress and depression and thus also damage to other aspects of health. This is consistent with the finding that psychological distress associated with unemployment was reported more frequently reported among white-collar than blue-collar workers.[8]

Unexpected economic adversity even among those with greater personal resources may be a particularly damaging at *older* ages,[9] and obtaining another job at an equivalent

level more difficult. As the mechanisms linking cognitive function and education with mortality may not be identical,[2] we examined these measures separately. This study uses Swedish register data to examine associations of unemployment with mortality among a cohort of men born between 1952 and 1956, to test the hypothesis that unemployment disproportionately eliminates health potential associated with better cognitive function and higher qualifications and that the effect varies by age. Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic recession and another period of significant economic contraction was beginning in 2001.

Methods

Study population

The cohort comprised all men born between 1st January 1952 and 31st December 1956 that were included in the Swedish Military Conscription Register.[10 11] At this time the majority of male Swedish citizens participated in the assessment for compulsory military service that took place in late adolescence and fewer than 4% of men were not involved due to chronic illness or disability. The assessments were between 1970 and 1975 and the majority at ages 18 and 19 years, with a small number after this time at later ages. A total of 284,198 men were identified and 2,564 were excluded due to data inconsistencies such as errors in the personal identification number, female sex or uncertain vital status. We then excluded 225 men from the analysis with improbable measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This resulted in a sample of 272,768 men with data at the start of follow-up in December

1990. We then excluded 35,161 men with missing data for: census (18,178); education (2,440); or the conscription assessments (28,483) that may have resulted from loss of records. The sample available for the main analysis comprised 234,782 men.

Measures

The conscription examination in late adolescence provided the following measures. Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic blood pressure were measured after rest in recumbent men using a sphygmomanometer. Physical working capacity was assessed using an electronically braked ergonometer for the maximum load sustained for six minutes, or an estimate was derived from a nomogram for shorter duration. Cognitive testing covered four domains: linguistic understanding (40 questions), spatial recognition (identifying geometric shapes), general knowledge (40 questions) and ability to follow mechanical instructions (problems presented as diagrams requiring knowledge of mechanics and basic physics). The results of the cognitive function tests were transformed into a single score with a value on a normalized standard scale ranging from 1 to 9. The conscripts underwent a psychological examination to assess their potential ability to cope with warfare and therefore providing an indication of their stress resilience, producing a score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in Swedish,[12] but it has been used in research reported in English.[13] The medical assessment produced a score of 0 to 9 to indicate the severity of any medical problems, such that 9 indicated no problem, with a decreasing score indicating increasing severity to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-defined problem (n=22).

Statistics Sweden provided socioeconomic and demographic data using the registers they administer,[14] including information on vital status and emigration from the Total Population register. Childhood social and material circumstances were estimated using data from the 1960 census, where the head of the household's occupation was characterised as manual, agricultural, farm owners/managers, office workers, business owners/managers, and others. The person per room ratio was divided into quarters of its distribution. The Longitudinal database of Education, Income, and Occupation (LISA) was used to obtain information on level of attained education in 1990, employment status in 1985, as well employment status and receipt of disability/chronic disease benefits in 1990 and 2001. Attained education – based on the duration of education required for the qualification - was divided into three categories: compulsory (up to nine years); up to three years post-compulsory; and over three years post-compulsory. Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of disability/chronic disease benefits at any time earlier in the year was recorded.

The Cause of Death Register[15] provided ICD codes on causes of death, including for suicide, where we also included undetermined intent as possible suicide.

Statistical analysis

Cox regression was used to examine the association of unemployment (compared with employment) with subsequent mortality risk over two periods: unemployment in 1990 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who received disability/chronic disease benefits at entry to either follow-up period were excluded from analysis in that period. Follow-up was to death, emigration or the end of the study period, whichever occurred first. The analysis was adjusted for socioeconomic

index of parents and household crowding in 1960, and the following conscription measures: BMI in categories as in table 1, height (continuous), physical working capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8, and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the later follow-up period) and region of residence. Attained age was used as the underlying time-scale for all models to achieve the most efficient adjustment for age. The analyses were stratified by the cognitive function score divided into equal thirds of its distribution and then by the three-category education variable. Further analyses excluded mortality due to suicide (including where the cause of death was recorded as undetermined intent). Analyses then excluded the first four years of follow-up after 1990 and 2001 to allow for 'selection to wear off'.[16 17]

A Cox regression model with follow-up over the entire study period (1990 to 2010) assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for the association with mortality for the combination of unemployment with cognitive function or with education. Unemployment was modelled as a time-dependent covariate and the analysis was adjusted for the potential confounding factors described above.

The statistical software used was Stata version 12/SE for Windows (StataCorp, College Station, Texas). Tests were 2-sided and statistical significance was defined as $p<0.05$ and 95% confidence intervals that do not include 1.00.

Ethical permission

Ethical permission to conduct this project was granted by the Uppsala Regional Ethics Committee (Dnr 2009/306).

Results

All of the characteristics investigated were statistically significantly associated with unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than 0.001, p values are not presented. Unemployment and receipt of a disability pension in both periods were associated with lower parental SEI, greater household crowding, BMI indicating underweight or obesity, diagnoses of more severe diseases at conscription, low stress resilience, lower level qualifications, shorter stature, lower physical working capacity, and lower cognitive function score. Higher diastolic blood pressure was associated with unemployment and disability pension, but the pattern is more complex for systolic blood pressure. The total number unemployed in 2001 was greater than in 1990 and the number on disability/chronic sickness benefit was notably greater in 2001. Overall, the distribution of educational attainment and cognitive function score among the employed was very similar between the two periods, but a higher proportion of those who experienced unemployment during the second period had lower qualifications and cognitive function scores.

During the period 1990 to 2001, unemployment compared with employment in 1990 was associated with a statistically significantly raised risk of mortality in each of the cognitive function and education strata, both before and after adjustment for the potential confounding factors (table 2). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. The results are graded by cognition and education, with the highest unemployment-related

mortality risk among men with the lowest cognitive function scores and education. Exclusion of deaths due to suicide altered the gradient of risk between the first two strata, but men with the highest cognitive function scores and qualifications remained at lowest risk of mortality if they experienced unemployment. Some reduction in magnitude of risk, but without loss of statistical significance, was observed when deaths during the first four years of follow-up were excluded to allow for the 'wearing off' of direct health selection.

During the period 2001 to 2010, unemployment compared with employment in 2001 was associated with a statistically significantly raised risk of mortality in each of the education strata both before and after adjustment for the potential confounding factors (table 3). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. In contrast with the earlier period, the unemployment-related mortality risk, when stratified by cognition or education, is reversed and consistently higher for the strata of those with the highest levels of cognitive function or education. It is noteworthy that the absolute rate of unemployment-related mortality is much more similar across the cognition and education strata; even though there is more of a gradient among the employed. In all of the adjusted models, after exclusion of death by suicide, and after allowing 'selection to wear off', the gradient of unemployment-related mortality remains reversed or eliminated compared with the earlier period: those with the higher level cognitive function scores and qualifications had higher hazard ratios for mortality associated with unemployment.

The interaction tests to assess effect modification by age/period are statistically significant for both cognitive function (p=0.004) and education (p=0.003), consistent with higher mortality among in men with better cognitive function or education when they experience unemployment at a later age.

Discussion

Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was associated with all-cause mortality: men with poorer cognitive function test scores and lower-level educational attainment were at greater relative risk (measured by hazard ratios) than men with higher qualifications. Unemployment in 2001 when the men were aged 45 to 49 years was also associated with subsequent mortality, but the gradient was reversed, such that the more intelligent and more highly qualified men were at greater relative risk of mortality following unemployment. The gradient of absolute unemployment-associated mortality rate, across cognition and education strata was attenuated substantially by unemployment at an older age in 2001.

Previous research using data from the USA found that low income was a greater relative risk for ischaemic heart disease and depression among individuals with markers of a relatively privileged childhood and higher qualifications.[5 7] Data from older adults in Britain revealed that similar economic adversity eliminated the lower depression risk associated with markers of earlier advantage.[6] We hypothesised that this *unexpected* adversity results in a form of disappointment, thus increasing the risk of disease through behavioural change and the systemic consequences of stress. This study is an extension of the disappointment paradox concept but using longitudinal rather than cross-sectional data. Unemployment at an older age among the more highly qualified and

those with higher cognitive function scores may represent a stressful exposure that is more unexpected or more difficult to cope with than unemployment experienced among men with fewer qualifications or lower cognitive function scores, as suggested by the higher levels of unemployment-related psychological distress observed among white-collar workers.[8] As we are concerned with unemployment as marker of socioeconomic adversity we did not adjust for other contemporaneous economic measures collinear with unemployment. The earlier research used diagnoses as the outcome[5-7] and the results could theoretically have been influenced by more highly educated individuals seeking health care: the use of mortality in this study is not at similar risk of bias through health service use.

It has long been observed that suicide rates increase both during periods of economic recession and also during phases of rapid economic growth; arguing that weakened social norms, rather than poverty alone, reduces social cohesion and thus increases suicide risk.[18] A sense of coherence is relevant to an individual's adaptive capacity for social stress[19] and unemployment may be damaging in this respect. Those with higher cognitive function and qualifications, signalling more advantages in earlier life, may be less well adapted to coping with unemployment-related stress.[6 7] This theoretical framework not only potentially explains associations with suicide (the risk of which can vary by age[20]), as our results are similar after exclusion of suicide. Poorer adaptation to social adversity has also been linked to increased risk of stroke,[21] indicating effects on the cardiovascular and possibly other systems.

Interaction analysis confirmed that the pattern of risk changed between the periods such that the greater risk of mortality among men with better cognition and

qualifications who experienced unemployment at an older age was disproportionately higher (a multiplicative effect). Older people who have less possibility to return to work may find the consequence of the associated economic adversity more challenging,[9] particularly during a period of economic contraction, despite the resources signalled by higher cognition and qualifications. This unemployment-associated risk of ill health may continue to increase with age.

Health selection can help to explain associations between unemployment and disease.[22] Direct health selection is where pre-existing illness increases the risk of unemployment. We tackled this by excluding men with disability and sickness benefits at study entry and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we excluded events (deaths) in the initial years of follow-up after unemployment to allow selection to 'wear off' when a high proportion of those with the most serious diseases pre-dating unemployment are expected to die,[16] as used in other studies of unemployment and mortality, including a previous study of unemployment in Sweden.[17] The earlier Swedish study presented evidence of direct health selection as there was statistically significant excess mortality in the first four years following unemployment but not subsequently.[17] Therefore we excluded the first four years of the follow-up in a sub-analysis. Even though the men who experienced unemployment in the second period of our study may have been more selected in terms of health, our procedures to tackle direct selection make this unlikely as an explanation for the reversal of the unemployment-mortality gradient by cognition or education.

Indirect health selection is where personal characteristics linked with raised unemployment risk are also risks for poor health.[22 23] We adjusted for a variety of

measures relevant to future health and mortality risk, including chronic illnesses, height,[24] blood pressure,[10] BMI,[25 26] cognition,[2 3] markers of physical fitness[26] and stress resilience. Men with the most severe disabilities or chronic illness preventing military service would not have undergone some of the tests at conscription and are thus not included in the analysis. Indirect health selection is unlikely to explain the disappearance at a later age of the relatively protective association with higher qualifications and cognition, as the opposite effect might be expected.

It should be emphasised that unemployment remained less common among the more highly educated men and those with higher cognitive function. This means that support and benefits will remain a bigger issue for the less highly qualified and more disadvantaged. Unemployment can result in persistent disadvantage, including through subsequent unstable employment,[27-29] so when experienced at an earlier age it can cause harm across an entire adult life. While it remains possible that earlier exit from the labour market helps to explain these results, it does not alter the fact that unemployment among older men is relatively more damaging across the social spectrum, suggesting this is a 'critical period' where interventions might be focused.[30]

The experience of unemployment can contribute to the risk of ill-health through several mechanisms.[1] Behavioural change following unemployment, such as increases in smoking (or failure to give up) and an unhealthy diet[27] can increase the risk of cardiovascular disease and cancer. The financial disadvantage associated with unemployment can persist even after finding a new job[27] and the association of poverty with mortality is well known.[31] Depression and stress resulting from unemployment is also likely to be relevant, as this has may raise mortality risk through behavioural and

possibly systemic mechanisms.[32] Stressful events and circumstances have been linked to an increase in mortality due to suicide and cardiovascular disease.[33] The mechanisms linking cognitive function and education with mortality may not be identical,[2] but the pattern of unemployment-related mortality risk is similar when stratified by cognition or education.

Limitations

Potential limitations of the study include its inclusion of only men, as women can also be affected adversely by unemployment. This was necessary as the detailed baseline data on health and function were collected during military conscription, which at the time was only available to men. Disentangling age and period effects in a single cohort can be problematic. The two time points differed in unemployment rate: the proportion unemployed was larger in the second period, thus possibly altering selection effects. To tackle possible selection bias we adjusted for multiple markers of susceptibility. We also excluded events during the first part of the follow-up period to allow direct health selection to 'wear off'. The study focused on unemployment only at two time points and these represent times when Sweden was entering periods of economic contraction: these were chosen when the study was designed and information on unemployment at other times was not included in our dataset. These measures will underestimate the experience of unemployment and does not take duration of unemployment into account. This is likely to make our estimates less precise rather than creating spurious results. There is a greater possibility of prior unemployment in the later period and thus greater unemployment duration, but our adjustment for previous unemployment did not indicate that this was driving the results. The focus of the study was on mortality as an objective endpoint. While this will underestimate the damage to health associated with

unemployment substantially, it makes it more feasible to tackle the effects of direct health selection, as less serious health events that could influence unemployment risk will not contribute so notably to mortality in the first years following unemployment that we excluded from the 'selection wearing off' analysis. Mortality is more likely to occur at older ages and causes of mortality vary by age.

Unemployment during periods of economic contraction is associated with raised mortality that may not be explained fully by direct or indirect health selection into unemployment. With increasing age, the experience of unemployment may be unexpectedly harmful to those with better cognition, higher qualifications and associated resources. This highlights the importance of supporting the entire population who experience unemployment during a recession and the greater vulnerability of older workers.

1. Janlert U, Hammarstrom A. Which theory is best? Explanatory models of the relationship between unemployment and health. *BMC public health* 2009;9:235.
2. Lager A, Bremberg S, Vagero D. The association of early IQ and education with mortality: 65 year longitudinal study in Malmo, Sweden. *Bmj* 2009;339:b5282.
3. Calvin CM, Deary IJ, Fenton C, et al. Intelligence in youth and all-cause-mortality: systematic review with meta-analysis. *International journal of epidemiology* 2011;40(3):626-44.
4. Batty GD, Wennerstad KM, Smith GD, et al. IQ in early adulthood and mortality by middle age: cohort study of 1 million Swedish men. *Epidemiology* 2009;20(1):100-9.
5. Osika W, Ehlin A, Montgomery SM. Does height modify the risk of angina associated with economic adversity? *Economics and human biology* 2006;4(3):398-411.
6. Montgomery SM, Netuveli G, Hildon Z, et al. Does financial disadvantage at older ages eliminate the potential for better health? *Journal of epidemiology and community health* 2007;61(10):891-5.
7. Osika W, Montgomery SM. Economic disadvantage modifies the association of height with low mood in the US, 2004: the disappointment paradox. *Economics and human biology* 2008;6(1):95-107.
8. D'Arcy C, Siddique CM. Unemployment and health: an analysis of "Canada Health Survey" data. *International journal of health services : planning, administration, evaluation* 1985;15(4):609-35.
9. McKee M, Stuckler D. Older people in the UK: under attack from all directions. *Age and ageing* 2013;42(1):11-3.
10. Sundstrom J, Neovius M, Tynelius P, et al. Association of blood pressure in late adolescence with subsequent mortality: cohort study of Swedish male conscripts. *Bmj* 2011;342:d643.
11. Whitley E, Batty GD, Gale CR, et al. Intelligence in early adulthood and subsequent risk of unintentional injury over two decades: cohort study of 1 109 475 Swedish men. *Journal of epidemiology and community health* 2010;64(5):419-25.
12. Lothigius J. *Verksamhetsinstruktion för Psykologer VIP95 (Psychological Test Manual used by the Swedish National Service Administration VIP95)*. Karlstad, 1995.
13. Nilsson PM, Nyberg P, Ostergren PO. Increased susceptibility to stress at a psychological assessment of stress tolerance is associated with impaired fetal growth. *International journal of epidemiology* 2001;30(1):75-80.
14. Statistics Sweden. http://www.scb.se/default___2154.aspx, (accessed 25 March 2013).
15. The Cause of Death Register. http://www.socialstyrelsen.se/register/dodsorsaksregistret, (accessed 25 March 2013).
16. Moser KA, Goldblatt PO, Fox AJ, et al. Unemployment and mortality: comparison of the 1971 and 1981 longitudinal study census samples. *British medical journal* 1987;294(6564):86-90.
17. Lundin A, Lundberg I, Hallsten L, et al. Unemployment and mortality--a longitudinal prospective study on selection and causation in 49321 Swedish middle-aged men. *Journal of epidemiology and community health* 2010;64(1):22-8.
18. Durkheim É. *Suicide: a study in sociology; translated by John A Spaulding and George Simpson*. New York: The Free Press of Glencoe, 1951.

19. Surtees PG, Wainwright NW, Khaw KT. Resilience, misfortune, and mortality: evidence that sense of coherence is a marker of social stress adaptive capacity. *Journal of psychosomatic research* 2006;61(2):221-7.
20. Varnik P. Suicide in the world. *International journal of environmental research and public health* 2012;9(3):760-71.
21. Surtees PG, Wainwright NW, Luben RL, et al. Adaptation to social adversity is associated with stroke incidence: evidence from the EPIC-Norfolk prospective cohort study. *Stroke; a journal of cerebral circulation* 2007;38(5):1447-53.
22. Bartley M, Ferrie J. Do we need to worry about the health effects of unemployment? *Journal of epidemiology and community health* 2010;64(1):5-6.
23. Montgomery SM, Bartley MJ, Cook DG, et al. Health and social precursors of unemployment in young men in Great Britain. *Journal of epidemiology and community health* 1996;50(4):415-22.
24. Magnusson PK, Gunnell D, Tynelius P, et al. Strong inverse association between height and suicide in a large cohort of Swedish men: evidence of early life origins of suicidal behavior? *The American journal of psychiatry* 2005;162(7):1373-5.
25. Magnusson PK, Rasmussen F, Lawlor DA, et al. Association of body mass index with suicide mortality: a prospective cohort study of more than one million men. *American journal of epidemiology* 2006;163(1):1-8.
26. Bellocco R, Jia C, Ye W, et al. Effects of physical activity, body mass index, waist-to-hip ratio and waist circumference on total mortality risk in the Swedish National March Cohort. *European journal of epidemiology* 2010;25(11):777-88.
27. Wadsworth ME, Montgomery SM, Bartley MJ. The persisting effect of unemployment on health and social well-being in men early in working life. *Social science & medicine* 1999;48(10):1491-9.
28. Virtanen P, Vahtera J, Kivimaki M, et al. Employment security and health. *Journal of epidemiology and community health* 2002;56(8):569-74.
29. Ferrie JE, Shipley MJ, Stansfeld SA, et al. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *Journal of epidemiology and community health* 2002;56(6):450-4.
30. Bartley M, Blane D, Montgomery S. Health and the life course: why safety nets matter. *Bmj* 1997;314(7088):1194-6.
31. Thomas B, Dorling D, Smith GD. Inequalities in premature mortality in Britain: observational study from 1921 to 2007. *Bmj* 2010;341:c3639.
32. Cohen F, Kemeny ME, Zegans LS, et al. Immune function declines with unemployment and recovers after stressor termination. *Psychosomatic medicine* 2007;69(3):225-34.
33. Fang F, Fall K, Mittleman MA, et al. Suicide and cardiovascular death after a cancer diagnosis. *The New England journal of medicine* 2012;366(14):1310-8.

Table 1. Population characteristics and subsequent unemployment in 1990 and 2001

	1990			2001		
	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)
Parental SEI 1960						
Manual workers	91 878 (41.5)	5274 (40.2)	1380 (46.9)	82 938 (41.2)	7413 (43.6)	5049 (47.3)
Agricultural workers	8592 (3.9)	471 (3.6)	120 (4.1)	7693 (3.8)	743 (4.4)	507 (4.7)
Farm owners/managers	22 510 (10.2)	948 (7.2)	206 (7.0)	20 931 (10.4)	1373 (8.1)	770 (7.2)
Office workers	61 748 (27.9)	3774 (28.7)	684 (23.2)	56 698 (28.1)	4199 (24.7)	2389 (22.4)
Business owners/managers	23 701 (10.7)	1569 (12.0)	263 (8.9)	21 690 (10.8)	1893 (11.1)	982 (9.2)
Others/unknown	13105 (5.9)	1093 (8.3)	291 (9.9)	11 557 (5.7)	1362 (8.0)	986 (9.2)
Household crowding, 1960						
≤2 people/ room	173 804 (78.5)	9883 (75.3)	2085 (70.8)	159 131 (79.0)	12 412 (73.1)	7538 (70.6)
> 2 people/ room	47 730 (21.5)	3246 (24.7)	859 (29.2)	42 376 (21.0)	4562 (26.9)	3145 (29.4)
BMI categories, kg/m²						
Underweight (<18.5)	25 476 (11.5)	1664 (12.7)	481 (16.3)	22 999 (11.4)	2106 (12.4)	1525 (14.3)
Normal weight (18.5, <25)	179 381 (81.0)	10 456 (79.6)	2234 (75.9)	163 723 (81.2)	13 451 (79.2)	8142 (76.2)
Overweight (25.0, <30)	14536 (6.6)	833 (6.3)	183 (6.2)	12 955 (6.4)	1191 (7.0)	837 (7.8)
Obese (≥30.0)	2141 (1.0)	176 (1.3)	46 (1.6)	1839 (0.9)	235 (1.4)	179 (1.7)
Summary disease score						
Very significant problem (0)	10 560 (4.8)	1613 (12.3)	897 (30.5)	8212 (4.1)	1920 (11.3)	2159 (20.2)
Significant problem (2-3)	6468 (2.9)	586 (4.5)	249 (8.5)	5481 (2.7)	782 (4.6)	698 (6.5)
Fairly significant (4-5)	16671 (7.5)	1061 (8.1)	246 (8.4)	14 782 (7.3)	1548 (9.1)	1032 (9.7)
No serious problem (6-8)	88 816 (40.1)	4832 (36.8)	830 (28.2)	81 106 (40.2)	6472 (38.1)	3774 (35.3)
No diagnosis (9)	98 997 (44.7)	5037 (38.4)	722 (24.5)	91 909 (45.6)	6260 (36.9)	3018 /28.3)
Ill-defined problem (1)	22 (0.0)	0 (0.0)	0 (0.0)	18 (0.0)	1 (0.0)	2 (0.0)
Stress resilience						
Low (1-3)	45 221 (20.4)	4407 (33.6)	1750 (59.4)	38 222 (19.0)	5927 (34.9)	5108 (47.8)
Moderate (4-6)	122 546 (55.3)	6092 (46.4)	1005 (34.1)	112 943 (56.0)	8227 (48.4)	4494 (42.1)
High (7-9)	53 767 (24.3)	2630 (20.0)	189 (6.4)	50 342 (25.0)	2829 (16.7)	1081 (10.1)
Education						
Compulsory	54 698 (24.7)	3634 (27.7)	1345 (45.7)	48 367 (24.0)	5254 (30.9)	4089 (38.3)
≤ 3 years post-compulsory	103 251 (46.6)	6595 (50.2)	1388 (47.1)	93 225 (46.3)	9019 (53.1)	5577 (52.2)
> 3 years post-compulsory	63 585 (28.7)	2900 (22.1)	211 (7.2)	59 915 (29.7)	2710 (16.0)	1017 (9.5)
Height*	178.7 (6.4)	178.4 (6.5)	177.7 (6.7)	178.8 (6.4)	178.1 (6.5)	177.8 (6.6)
Physical working capacity*	6.3 (1.8)	6.0 (1.8)	5.6 (1.8)	6.4 (1.8)	6.0 (1.8)	5.8 (1.8)
Systolic blood pressure*	127.7(11.1)	127.0(11.1)	128.1 (11.3)	127.7 (11.1)	127.3(11.0)	127.8 (11.4)
Diastolic blood pressure*	71.6 (8.6)	71.7 (8.6)	73.0 (9.0)	71.6 (8.6)	71.8 (8.8)	72.3 (8.8)
Cognitive function*	5.2 (2.0)	5.0 (2.0)	3.82 (2.1)	5.3 (1.9)	4.7 (2.0)	4.1 (2.0)
Total *(row percentages)*	*221 534 (93.2)*	*13 129 (5.5)*	*2944 (1.2)*	*201 507 (87.9)*	*16 983 (7.4)*	*10 683(4.7)*

Table 2. Unemployment in 1990 and mortality risk (1990-2001) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	846 / 43 637	1.78 (1.67-1.91)	Ref.	Ref.	Ref.	Ref.
Unemployed	198 / 3206	5.87 (5.10-6.74)	3.33 (2.85-3.89)	2.43 (2.06-2.88)	2.40 (1.99-2.90)	2.25 (1.83-2.75)
Cognitive score 4-6						
Employed	1655 / 117 393	1.30 (1.24-1.36)	Ref.	Ref.	Ref.	Ref.
Unemployed	281 / 6799	3.96 (3.52-4.45)	3.08 (2.72-3.50)	2.33 (2.04-2.67)	2.50 (2.15-2.90)	2.33 (1.98-2.74)
Cognitive score 7-9						
Employed	604 / 60 504	0.92 (0.85-1.00)	Ref.	Ref.	Ref.	Ref.
Unemployed	67 / 3124	2.13 (1.68-2.71)	2.33 (1.81-3.00)	1.85 (1.42-2.40)	1.80 (1.33-2.43)	1.53 (1.08-2.16)
EDUCATION						
Compulsory education						
Employed	1015/54 698	1.71 (1.60-1.81)	Ref.	Ref.	Ref.	Ref.
Unemployed	208/3634	5.47 (4.78-6.27)	3.25 (2.80-3.77)	2.35 (1.99-2.76)	2.31 (1.93-2.76)	2.23 (1.83-2.72)
≤ 3 years post-compulsory education						
Employed	1524/103 251	1.36 (1.29-1.43)	Ref.	Ref.		
Unemployed	291/6595	4.21 (3.76-4.73)	3.14 (2.77-3.56)	2.25 (1.97-2.58)	2.40 (2.06-2.80)	2.19 (1.86-2.58)
> 3 years post-compulsory education						
Employed	566/63 585	0.83 (0.76-0.90)	Ref.	Ref.	Ref.	Ref.
Unemployed	47/2900	1.61 (1.21-2-15)	1.98 (1.47-2.66)	1.90 (1.40-2.57)	1.87 (1.32-2.66)	1.67 (1.13-2.46)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

Table 3. Unemployment in 2001 and mortality risk (2001-2010) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	790 / 37 222	2.65 (2.47 -2.84)	Ref.	Ref.	Ref.	Ref.
Unemployed	328 / 5008	8.41 (7.55-9.38)	3.19 (2.80-3.63)	2.76 (2.41-3.17)	2.80 (2.42-3.24)	2.64 (2.22-3.15)
Cognitive score 4-6						
Employed	1751 / 107 598	2.03 (1.94-2.13)	Ref.	Ref.	Ref.	Ref.
Unemployed	500 / 8783	7.35 (6.74-8.03)	3.63 (3.29-4.01)	3.03 (2.73-3.37)	3.03 (2.71-3.40)	2.73 (2.36-3.15)
Cognitive score 7-9						
Employed	759 / 56 687	1.67 /1.56-1.80)	Ref.	Ref.	Ref.	Ref.
Unemployed	143 / 3192	5.83 (4.95-6.86)	3.49 (2.92-4.18)	2.85(2.36-3.45)	2.91 (2.38-3.56)	3.02 (2.37-3.85)
EDUCATION						
Compulsory education						
Employed	1000/48 367	2.58 (2.43-2.75)	Ref.	Ref.	Ref.	Ref.
Unemployed	332/5254	8.17 (7.34-9.10)	3.18 (2.81-3.60)	2.81 (2.47-3.21)	2.84 (2.47-3.27)	2.67 (2.25-3.18)
≤ 3 years post-compulsory education						
Employed	1615/93 225	2.16 (2.06-2.27)	Ref.	Ref.	Ref.	Ref.
Unemployed	533/9019	7.61 (6.99-8.29)	3.54 (3.21-3.90)	2.87 (2.58-3.19)	2.91 (2.60-3.25)	2.67 (2.32-3.07)
> 3 years post-compulsory education						
Employed	685/59 915	1.43 (1.33 – 1.54)	Ref.	Ref.	Ref.	Ref.
Unemployed	106/2710	5.07 (4.19-6.13)	3.54 (2.88-4.34)	3.44 (2.78-4.25)	3.37 (2.68-4.23)	3.43 (2.58-4.54)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

Mortality ~~Unemployment~~ following unemployment ~~in later working life eliminates health potential associated with cognition and education~~during an economic downturn: Swedish register-based cohort study

Scott Montgomery,[1,2,3] Ruzan Udumyan,[1,2] Anders Magnuson, [1] Walter Osika, [4] Per-Ola Sundin,[2,5] David Blane[6]

1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85 Örebro, Sweden.
2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro, Sweden.
3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Insitutet, SE-171 76 Stockholm, Sweden.
4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
6. Department of Primary Care and Public Health, School of Public Health, Imperial College London W6 8RP, UK.

Correspondence: Professor Scott Montgomery
Clinical Epidemiology and Biostatistics
S-h~~H~~uset
Örebro University Hospital
701 85 Örebro
Sweden
Telephone +46 19 602 6210
scott.montgomery@orebroll.se

Word count: 2964~~2~~ (abstract); 3~~4~~32~~7~~1~~1~~ (text)

Acknowledgements: This study received support from Economic and Social Research Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to prepare the tables.

The study sponsors (ESRC and Örebro University) had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and clarified codes and measures required for the analysis. SM drafted the manuscript and all contributors were involved in critical editing. SM will act as guarantor.

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro University to support this work. None of the authors, their spouses, partners, or children have financial or non-financial relationships that may be relevant to the submitted work.

Data sharing: no additional data available, as the ethical permission does not allow for provision of data to individuals not in the research group.

ABSTRACT

Objective

To investigate if unemployment during an economic downturn ~~reduces health potential~~is associated with mortality, even among men with ~~with~~ markers of better health (higher cognitive function scores and ~~qualifications~~qualifications), and to assess whether the associations vary by age at unemployment.

Design and Setting National longitudinal cohort study using Swedish register data. The follow-up periods (1990-2001 and 2001-2010) were chosen as Sweden entered periods of significant economic contraction in 1990 and 2001.

Participants A representative sample of m~~M~~en from the general population (n=234,782) born between 1952 and 1956 who participated in military conscription examinations.

Main outcome measure All-cause mortality.

Results Unemployment compared with employment in 1991 (ages 34 to 38 years) produced adjusted hazard ratios (with 95% confidence intervals) for all-cause mortality (3651 deaths) during follow-up to 2001 and after stratification by education of 2.35 (1.99 to 2.76) for compulsory education, 2.25 (1.97 to 2.58) for up to three years post-compulsory education and 1.90 (1.40 to 2.57) for more than three years post-compulsory education. When unemployment was compared with employment in 2001 (ages 45 to 49 years) with follow-up to 2010, the pattern of mortality risk (4271 deaths) stratified by education was reversed, producing adjusted hazard ratios of 2.81 (2.47 to 3.21) for compulsory education, 2.87 (2.58 to 3.19) for up to three years post-compulsory education and 3.44 (2.78 to 4.25) for more than three years post-compulsory education. Interaction testing confirmed effect modification by age/period

Formatted: Font: Not Bold

(p=0.003). The degree of gradient reversal was slightly less pronounced after stratification by cognitive function but produced a similar pattern of results (p =0.004).

Conclusions Unemployment at older ages is associated with greater mortality risk than at younger ages, with the greatest relative increase in risk among men with markers of better health, suggesting the greater vulnerability of all older workers to unemployment-associated exposures.

~~Unemployment at older ages may eliminate health potential associated with higher cognitive function and qualifications.~~

Introduction

Economic recession and associated austerity measures result in increased unemployment, which is linked with poorer health and excess mortality through a variety of mechanisms.[1] During a recession, unemployment may be experienced by a broader spectrum of the working population rather than just more disadvantaged individuals. Does this atypical pattern of exposure to unemployment have unexpected health consequences?

Better cognitive function and higher levels of education are associated with better health ~~greater potential for good health~~ and reduced mortality risk in later life.[2-4] A review of intelligence in youth and all-cause mortality highlighted the likely importance of economic and social characteristics in adulthood in explaining the association.[3] Further clarification may be gained by examining how economic disadvantage such as unemployment modifies the association of intelligence in adolescence with adult mortality risk.

Better cognitive function and educational attainment confer protection against unemployment and facilitate a more rapid transition back to employment from unemployment, thus reducing the duration of exposure to unemployment-associated adversity. Therefore, health following experience of unemployment should be better among those with better cognitive function and the more highly qualified. However, in earlier studies we demonstrated that *unexpected* financial adversity is disproportionately damaging to health,[5-7] where adult economic disadvantage was experienced among those with pre-existing markers of better health and economic potential signalled by markers of childhood advantage. The disappointment paradox[7] hypothesises that when individuals with greater potential and expectations encounter economic adversity in adulthood the experience is relatively unexpected, resulting in higher levels of stress and depression and thus also damage to other aspects of health. This is consistent with the finding that psychological distress associated with unemployment was reported more frequently reported among white-collar than blue-collar workers.[8]

Unexpected economic adversity even among those with greater personal resources may be a particularly damaging at *older* ages,[9] and obtaining another job at an equivalent level more difficult. As the mechanisms linking cognitive function and education with mortality may not be identical,[2] we examined these measures separately. This study uses Swedish register data to examine associations of unemployment with mortality among a cohort of men born between 1952 and 1956, to test the hypothesis that unemployment disproportionately eliminates health potential associated with better cognitive function and higher qualifications and that the effect varies by age.

Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic recession and another period of significant economic contraction was beginning in 2001.

Methods

Study population

The cohort comprised all men born between 1st January 1952 and 31st December 1956 that were included in the Swedish Military Conscription Register.[10 11] At this time the majority of male Swedish citizens participated in the assessment for compulsory military service that took place in late adolescence and fewer than 4% of men were not involved due to chronic illness or disability. The assessments were between 1970 and 1975 and the majority at ages 18 and 19 years, with a small number after this time at later ages. A total of 284,198 men were identified and 2,564 were excluded due to data inconsistencies such as errors in the personal identification number, female sex or uncertain vital status. We then excluded 225 men from the analysis with improbable measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This resulted in a sample of 272,768 men with data at the start of follow-up in December 1990. We then excluded 35,161 men with missing data for: census (18,178); education (2,440); or the conscription assessments (28,483) that may have resulted from loss of records. The sample available for the main analysis comprised 234,782 men.

Measures

The conscription examination in late adolescence provided the following measures. Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic blood pressure were measured after rest in recumbent men using a sphygmomanometer. Physical working capacity was assessed using an electronically braked ergonometer for the maximum load sustained for six minutes, or an estimate was derived from a nomogram for shorter duration. Cognitive testing covered four domains: linguistic understanding (40 questions), spatial recognition (identifying geometric shapes), general knowledge (40 questions) and ability to follow mechanical instructions (problems presented as diagrams requiring knowledge of mechanics and basic physics). The results of the cognitive function tests were transformed into a single score with a value on a normalized standard scale ranging from 1 to 9. The conscripts underwent a psychological examination to assess their potential ability to cope with warfare and therefore providing an indication of their stress resilience, producing a score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in Swedish,[12] but it has been used in research reported in English.[13] The medical assessment produced a score of 0 to 9 to indicate the severity of any medical problems, such that 9 indicated no problem, with a decreasing score indicating increasing severity to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-defined problem (n=22).

Statistics Sweden provided socioeconomic and demographic data using the registers they administer,[14] including information on vital status and emigration from the Total Population register. Childhood social and material circumstances were estimated using data from the 1960 census, where the head of the household's occupation was characterised as manual, agricultural, farm owners/managers, office workers, business

owners/managers, and others. The person per room ratio was divided into quarters of its distribution. The Longitudinal database of Education, Income, and Occupation (LISA) was used to obtain information on level of attained education in 1990, employment status in 1985, as well employment status and receipt of disability/chronic disease benefits in 1990 and 2001. Attained education – based on the duration of education required for the qualification - was divided into three categories: compulsory (up to nine years); up to three years post-compulsory; and over three years post-compulsory. Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of disability/chronic disease benefits at any time earlier in the year was recorded.

The Cause of Death Register[15] provided ICD codes on causes of death, including for suicide, where we also included undetermined intent as possible suicide.

Statistical analysis

Cox regression was used to examine the association of unemployment (compared with employment) with subsequent mortality risk over two periods: unemployment in 1990 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who received disability/chronic disease benefits at entry to either follow-up period were excluded from analysis in that period. Follow-up was to death, emigration or the end of the study period, whichever occurred first. The analysis was adjusted for socioeconomic index of parents and household crowding in 1960, and the following conscription measures: BMI in categories as in table 1, height (continuous), physical working capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8, and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the

later follow-up period) and region of residence. Attained age was used as the underlying time-scale for all models to achieve the most efficient adjustment for age. The analyses were stratified by the cognitive function score divided into equal thirds of its distribution and then by the three-category education variable. Further analyses excluded mortality due to suicide (including where the cause of death was recorded as undetermined intent). Analyses then excluded the first four years of follow-up after 1990 and 2001 to allow for 'selection to wear off'.[16 17]

A Cox regression model with follow-up over the entire study period (1990 to 2010) assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for the association with mortality for the combination of unemployment with cognitive function or with education. Unemployment was modelled as a time-dependent covariate and the analysis was adjusted for the potential confounding factors described above.

The statistical software used was Stata version 12/SE for Windows (StataCorp, College Station, Texas). Tests were 2-sided and statistical significance was defined as $p<0.05$ and 95% confidence intervals that do not include 1.00.

Ethical permission

Ethical permission to conduct this project was granted by the Uppsala Regional Ethics Committee (Dnr 2009/306).

Results

All of the characteristics investigated were statistically significantly associated with unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than

0.001, p values are not presented. Unemployment and receipt of a disability pension in both periods were associated with lower parental SEI, greater household crowding, BMI indicating underweight or obesity, diagnoses of more severe diseases at conscription, low stress resilience, lower level qualifications, shorter stature, lower physical working capacity, and lower cognitive function score. Higher diastolic blood pressure was associated with unemployment and disability pension, but the pattern is more complex for systolic blood pressure. The total number unemployed in 2001 was greater than in 1990 and the number on disability/chronic sickness benefit was notably greater in 2001. Overall, the distribution of educational attainment and cognitive function score among the employed was very similar between the two periods, but a higher proportion of those who experienced unemployment during the second period had lower qualifications and cognitive function scores.

During the period 1990 to 2001, unemployment compared with employment in 1990 was associated with a statistically significantly raised risk of mortality in each of the cognitive function and education strata, both before and after adjustment for the potential confounding factors (table 2). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. The results are graded by cognition and education, with the highest unemployment-related mortality risk among men with the lowest cognitive function scores and education. Exclusion of deaths due to suicide altered the gradient of risk between the first two strata, but men with the highest cognitive function scores and qualifications remained at lowest risk of mortality if they experienced unemployment. Some reduction in magnitude of risk, but without loss of statistical significance, was observed when deaths

during the first four years of follow-up were excluded to allow for the 'wearing off' of direct health selection.

During the period 2001 to 2010, unemployment compared with employment in 2001 was associated with a statistically significantly raised risk of mortality in each of the education strata both before and after adjustment for the potential confounding factors (table 3). Patterns of association for unemployment with mortality are similar whether stratified by cognitive function or by education. In contrast with the earlier period, the unemployment-related mortality risk, when stratified by cognition or education, is reversed and consistently higher for the strata of those with the highest levels of cognitive function or education. It is noteworthy that the absolute rate of unemployment-related mortality is much more similar across the cognition and education strata; even though there is more of a gradient among the employed. In all of the adjusted models, after exclusion of death by suicide, and after allowing 'selection to wear off', the gradient of unemployment-related mortality remains reversed or eliminated compared with the earlier period: those with the higher level cognitive function scores and qualifications had higher hazard ratios for mortality associated with unemployment.

The interaction tests to assess effect modification by age/period are statistically significant for both cognitive function (p=0.004) and education (p=0.003), consistent with higher mortality among in men with better cognitive function or education when they experience unemployment at a later age.

Discussion

Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was associated with all-cause mortality: men with poorer cognitive function test scores and lower-level educational attainment were at greater relative risk (measured by hazard ratios) than men with higher qualifications. Unemployment in 2001 when the men were aged 45 to 49 years was also associated with subsequent mortality, but the gradient was reversed, such that the more intelligent and more highly qualified men were at greater relative risk of mortality following unemployment. The gradient of absolute unemployment-associated mortality rate, across cognition and education strata was attenuated substantially by unemployment at an older age in 2001.

Previous research using data from the USA found that low income was a greater relative risk for ischaemic heart disease and depression among individuals with markers of a relatively privileged childhood and higher qualifications.[5 7] Data from older adults in Britain revealed that similar economic adversity eliminated the ~~health potential for a~~ lower depression risk associated with markers of earlier advantage.[6] We hypothesised that this *unexpected* adversity results in a form of disappointment, thus increasing the risk of disease through behavioural change and the systemic consequences of stress. This study is an extension of the disappointment paradox concept but using longitudinal rather than cross-sectional data. Unemployment at an older age among the more highly qualified and those with higher cognitive function scores may represent a stressful exposure that is more unexpected or more difficult to cope with than unemployment experienced among men with fewer qualifications or lower cognitive function scores, as suggested by the higher levels of unemployment-related psychological distress observed among white-collar workers.[8] ~~.~~ As we are concerned with unemployment as marker of socioeconomic adversity we did not adjust for other contemporaneous economic

measures collinear with unemployment. The earlier research used diagnoses as the outcome[5-7] and the results could theoretically have been influenced by more highly educated individuals seeking health care: the use of mortality in this study is not at similar risk of bias through health service use.

It has long been observed that suicide rates increase both during periods of economic recession and also during phases of rapid economic growth; arguing that weakened social norms, rather than poverty alone, reduces social cohesion and thus increases suicide risk.[18] A sense of coherence is relevant to an individual's adaptive capacity for social stress[19] and unemployment may be damaging in this respect. Those with higher cognitive function and qualifications, signalling more advantages in earlier life, may be less well adapted to coping with unemployment-related stress.[6 7] This theoretical framework not only potentially explains associations with suicide (the risk of which can vary by age[20]), as our results are similar after exclusion of suicide. Poorer adaptation to social adversity has also been linked to increased risk of stroke,[21] indicating effects on the cardiovascular and possibly other systems.

Interaction analysis confirmed that the pattern of risk changed between the periods such that the greater risk of mortality among men with better cognition and qualifications who experienced unemployment at an older age was disproportionately higher (a multiplicative effect). Older people who have less possibility to return to work may find the consequence of the associated economic adversity more challenging,[9] particularly during a period of economic contraction, despite the resources signalled by higher cognition and qualifications. This unemployment-associated risk of ill health may continue to increase with age.

Health selection can help to explain associations between unemployment and disease.[22] Direct health selection is where pre-existing illness increases the risk of unemployment. We tackled this by excluding men with disability and sickness benefits at study entry and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we excluded events (deaths) in the initial years of follow-up after unemployment to allow selection to 'wear off' when a high proportion of those with the most serious diseases pre-dating unemployment are expected to die,[16] as used in other studies of unemployment and mortality, including a previous study of unemployment in Sweden.[17] The earlier Swedish study presented evidence of direct health selection as there was statistically significant excess mortality in the first four years following unemployment but not subsequently.[17] Therefore we excluded the first four years of the follow-up in a sub-analysis. Even though the men who experienced unemployment in the second period of our study may have been more selected in terms of health, our procedures to tackle direct selection make this unlikely as an explanation for the reversal of the unemployment-mortality gradient by cognition or education.

Indirect health selection is where personal characteristics linked with raised unemployment risk are also risks for poor health.[22 23] We adjusted for a variety of measures relevant to future health and mortality risk, including chronic illnesses, height,[24] blood pressure,[10] BMI,[25 26] cognition,[2 3] markers of physical fitness[26] and stress resilience. Men with the most severe disabilities or chronic illness preventing military service would not have undergone some of the tests at conscription and are thus not included in the analysis. Indirect health selection is unlikely to explain the

disappearance at a later age of the relatively protective association with higher qualifications and cognition, as the opposite effect might be expected.

It should be emphasised that unemployment remained less common among the more highly educated men and those with higher cognitive function. This means that support and benefits will remain a bigger issue for the less highly qualified and more disadvantaged. Unemployment can result in persistent disadvantage, including through subsequent unstable employment,[27-29] so when experienced at an earlier age it can cause harm across an entire adult life. While it remains possible that earlier exit from the labour market helps to explain these results, it does not alter the fact that unemployment among older men is relatively more damaging across the social spectrum, suggesting this is a 'critical period' where interventions might be focused.[30]

The experience of unemployment can contribute to the risk of ill-health through several mechanisms.[1] Behavioural change following unemployment, such as increases in smoking (or failure to give up) and an unhealthy diet[27] can increase the risk of cardiovascular disease and cancer. The financial disadvantage associated with unemployment can persist even after finding a new job[27] and the association of poverty with mortality is well known.[31] Depression and stress resulting from unemployment is also likely to be relevant, as this has may raise mortality risk through behavioural and possibly systemic mechanisms.[32] Stressful events and circumstances have been linked to an increase in mortality due to suicide and cardiovascular disease.[33] The mechanisms linking cognitive function and education with mortality may not be identical,[2] but the pattern of unemployment-related mortality risk is similar when stratified by cognition or education.

Limitations

Potential limitations of the study include its inclusion of only men. , as women can also be affected adversely by unemployment. -This was necessary as the detailed baseline data on health and function were collected during military conscription, which at the time was only available to men. Disentangling age and period effects in a single cohort can be problematic. The two time points differed in unemployment rate: the proportion unemployed was larger in the second period, thus possibly altering selection effects. To tackle possible selection bias we adjusted for multiple markers of susceptibility. We also excluded events during the first part of the follow-up period to allow direct health selection to 'wear off'. The study focused on unemployment only at two time points and these represent times when Sweden was entering periods of economic contraction: these were chosen when the study was designed and information on unemployment at other times was not included in our dataset. These measures will underestimate the experience of unemployment and does not take duration of unemployment into account. This is likely to make our estimates less precise rather than creating spurious results. There is a greater possibility of prior unemployment in the later period and thus greater unemployment duration, but our adjustment for previous unemployment did not indicate that this was driving the results. The focus of the study was on mortality as an objective endpoint. While this will underestimate the damage to health associated with unemployment substantially, it makes it more feasible to tackle the effects of direct health selection, as less serious health events that could influence unemployment risk will not contribute so notably to mortality in the first years following unemployment that we excluded from the 'selection wearing off' analysis. Mortality is more likely to occur at older ages and causes of mortality vary by age.

Unemployment during periods of economic contraction is associated with raised mortality that may not be explained fully by direct or indirect health selection into unemployment. With increasing age, the experience of unemployment may be unexpectedly harmful to those with better cognition, higher qualifications and associated resources. This highlights the importance of supporting the entire population who experience unemployment during a recession and the greater vulnerability of older workers~~, irrespective of their health potential indicated by markers of protection such as cognitive function and education~~.

ARTICLE SUMMARY

Article focus

- Unemployment is associated with poor health and excess mortality, which is explained by a variety of mechanisms.

- Higher qualifications and better cognitive function are associated with ~~the potential for~~ better health.

- Economic adversity has been ~~shown to eliminate~~ associated with disproportionate damage to health ~~potential disproportionately~~ among individuals who were previously advantaged, so unemployment may have this effect among those with higher qualifications and better cognitive function.

Key messages

- Unemployment in later working life is more likely to be associated with ~~eliminate~~ damage to heath ~~potential associated~~among those with better cognitive function and qualifications than unemployment at a younger age.

- This emphasises the importance of supporting all older workers who become unemployed, including those with characteristics ~~signalling higher levels of health potential~~usually associated with better health.

Strengths and limitations of this study

- The study benefits from use of a large longitudinal cohort with prospectively recorded information.
- Unemployment is only measured at limited number of time points, so the study cannot examine duration of exposure.
- The use of Swedish military conscription data limited the study to men, so it is not known if findings would be similar among women.

1. Janlert U, Hammarstrom A. Which theory is best? Explanatory models of the relationship between unemployment and health. *BMC public health* 2009;9:235.
2. Lager A, Bremberg S, Vagero D. The association of early IQ and education with mortality: 65 year longitudinal study in Malmo, Sweden. *Bmj* 2009;339:b5282.
3. Calvin CM, Deary IJ, Fenton C, Roberts BA, Der G, Leckenby N, et al. Intelligence in youth and all-cause-mortality: systematic review with meta-analysis. *International journal of epidemiology* 2011;40(3):626-44.
4. Batty GD, Wennerstad KM, Smith GD, Gunnell D, Deary IJ, Tynelius P, et al. IQ in early adulthood and mortality by middle age: cohort study of 1 million Swedish men. *Epidemiology* 2009;20(1):100-9.
5. Osika W, Ehlin A, Montgomery SM. Does height modify the risk of angina associated with economic adversity? *Economics and human biology* 2006;4(3):398-411.
6. Montgomery SM, Netuveli G, Hildon Z, Blane D. Does financial disadvantage at older ages eliminate the potential for better health? *Journal of epidemiology and community health* 2007;61(10):891-5.
7. Osika W, Montgomery SM. Economic disadvantage modifies the association of height with low mood in the US, 2004: the disappointment paradox. *Economics and human biology* 2008;6(1):95-107.
8. ~~D'Arcy C, Siddique CM. Unemployment and health: an analysis of "Canada Health Survey" data. *International journal of health services : planning, administration, evaluation* 1985;15(4):609-35.~~
9. ~~9.~~ D'Arcy C, Siddique CM. Unemployment and health: an analysis of "Canada Health Survey" data. *International journal of health services : planning, administration, evaluation* 1985;15(4):609-35.
9. McKee M, Stuckler D. Older people in the UK: under attack from all directions. *Age and ageing* 2013;42(1):11-3.
10. Sundstrom J, Neovius M, Tynelius P, Rasmussen F. Association of blood pressure in late adolescence with subsequent mortality: cohort study of Swedish male conscripts. *Bmj* 2011;342:d643.
11. Whitley E, Batty GD, Gale CR, Deary IJ, Tynelius P, Rasmussen F. Intelligence in early adulthood and subsequent risk of unintentional injury over two decades: cohort study of 1 109 475 Swedish men. *Journal of epidemiology and community health* 2010;64(5):419-25.
12. Lothigius J. *Verksamhetsinstruktion för Psykologer VIP95 (Psychological Test Manual used by the Swedish National Service Administration VIP95)*. Karlstad, 1995.
13. Nilsson PM, Nyberg P, Ostergren PO. Increased susceptibility to stress at a psychological assessment of stress tolerance is associated with impaired fetal growth. *International journal of epidemiology* 2001;30(1):75-80.
14. Statistics Sweden. http://www.scb.se/default___2154.aspx, (accessed 25 March 2013).
15. The Cause of Death Register. http://www.socialstyrelsen.se/register/dodsorsaksregistret, (accessed 25 March 2013).
16. Moser KA, Goldblatt PO, Fox AJ, Jones DR. Unemployment and mortality: comparison of the 1971 and 1981 longitudinal study census samples. *British medical journal* 1987;294(6564):86-90.

17. Lundin A, Lundberg I, Hallsten L, Ottosson J, Hemmingsson T. Unemployment and mortality--a longitudinal prospective study on selection and causation in 49321 Swedish middle-aged men. *Journal of epidemiology and community health* 2010;64(1):22-8.
18. Durkheim É. *Suicide: a study in sociology; translated by John A Spaulding and George Simpson*. New York: The Free Press of Glencoe, 1951.
19. Surtees PG, Wainwright NW, Khaw KT. Resilience, misfortune, and mortality: evidence that sense of coherence is a marker of social stress adaptive capacity. *Journal of psychosomatic research* 2006;61(2):221-7.
20. Varnik P. Suicide in the world. *International journal of environmental research and public health* 2012;9(3):760-71.
21. Surtees PG, Wainwright NW, Luben RL, Wareham NJ, Bingham SA, Khaw KT. Adaptation to social adversity is associated with stroke incidence: evidence from the EPIC-Norfolk prospective cohort study. *Stroke; a journal of cerebral circulation* 2007;38(5):1447-53.
22. Bartley M, Ferrie J. Do we need to worry about the health effects of unemployment? *Journal of epidemiology and community health* 2010;64(1):5-6.
23. Montgomery SM, Bartley MJ, Cook DG, Wadsworth ME. Health and social precursors of unemployment in young men in Great Britain. *Journal of epidemiology and community health* 1996;50(4):415-22.
24. Magnusson PK, Gunnell D, Tynelius P, Davey Smith G, Rasmussen F. Strong inverse association between height and suicide in a large cohort of Swedish men: evidence of early life origins of suicidal behavior? *The American journal of psychiatry* 2005;162(7):1373-5.
25. Magnusson PK, Rasmussen F, Lawlor DA, Tynelius P, Gunnell D. Association of body mass index with suicide mortality: a prospective cohort study of more than one million men. *American journal of epidemiology* 2006;163(1):1-8.
26. Bellocco R, Jia C, Ye W, Lagerros YT. Effects of physical activity, body mass index, waist-to-hip ratio and waist circumference on total mortality risk in the Swedish National March Cohort. *European journal of epidemiology* 2010;25(11):777-88.
27. Wadsworth ME, Montgomery SM, Bartley MJ. The persisting effect of unemployment on health and social well-being in men early in working life. *Social science & medicine* 1999;48(10):1491-9.
28. Virtanen P, Vahtera J, Kivimaki M, Pentti J, Ferrie J. Employment security and health. *Journal of epidemiology and community health* 2002;56(8):569-74.
29. Ferrie JE, Shipley MJ, Stansfeld SA, Marmot MG. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *Journal of epidemiology and community health* 2002;56(6):450-4.
30. Bartley M, Blane D, Montgomery S. Health and the life course: why safety nets matter. *Bmj* 1997;314(7088):1194-6.
31. Thomas B, Dorling D, Smith GD. Inequalities in premature mortality in Britain: observational study from 1921 to 2007. *Bmj* 2010;341:c3639.
32. Cohen F, Kemeny ME, Zegans LS, Johnson P, Kearney KA, Stites DP. Immune function declines with unemployment and recovers after stressor termination. *Psychosomatic medicine* 2007;69(3):225-34.

33. Fang F, Fall K, Mittleman MA, Sparen P, Ye W, Adami HO, et al. Suicide and cardiovascular death after a cancer diagnosis. *The New England journal of medicine* 2012;366(14):1310-8.

Table 1. Population characteristics and subsequent unemployment in 1990 and 2001

	1990			2001		
	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)	Employed N (%) * mean (SD)	Unemployed N (%) * mean (SD)	Disability pension N (%) * mean (SD)
Parental SEI 1960						
Manual workers	91 878 (41.5)	5274 (40.2)	1380 (46.9)	82 938 (41.2)	7413 (43.6)	5049 (47.3)
Agricultural workers	8592 (3.9)	471 (3.6)	120 (4.1)	7693 (3.8)	743 (4.4)	507 (4.7)
Farm owners/managers	22 510 (10.2)	948 (7.2)	206 (7.0)	20 931 (10.4)	1373 (8.1)	770 (7.2)
Office workers	61 748 (27.9)	3774 (28.7)	684 (23.2)	56 698 (28.1)	4199 (24.7)	2389 (22.4)
Business owners/managers	23 701 (10.7)	1569 (12.0)	263 (8.9)	21 690 (10.8)	1893 (11.1)	982 (9.2)
Others/unknown	13105 (5.9)	1093 (8.3)	291 (9.9)	11 557 (5.7)	1362 (8.0)	986 (9.2)
Household crowding, 1960						
≤2 people/ room	173 804 (78.5)	9883 (75.3)	2085 (70.8)	159 131 (79.0)	12 412 (73.1)	7538 (70.6)
> 2 people/ room	47 730 (21.5)	3246 (24.7)	859 (29.2)	42 376 (21.0)	4562 (26.9)	3145 (29.4)
BMI categories, kg/m²						
Underweight (<18.5)	25 476 (11.5)	1664 (12.7)	481 (16.3)	22 999 (11.4)	2106 (12.4)	1525 (14.3)
Normal weight (18.5, <25)	179 381 (81.0)	10 456 (79.6)	2234 (75.9)	163 723 (81.2)	13 451 (79.2)	8142 (76.2)
Overweight (25.0, <30)	14536 (6.6)	833 (6.3)	183 (6.2)	12 955 (6.4)	1191 (7.0)	837 (7.8)
Obese (≥30.0)	2141 (1.0)	176 (1.3)	46 (1.6)	1839 (0.9)	235 (1.4)	179 (1.7)
Summary disease score						
Very significant problem (0)	10 560 (4.8)	1613 (12.3)	897 (30.5)	8212 (4.1)	1920 (11.3)	2159 (20.2)
Significant problem (2-3)	6468 (2.9)	586 (4.5)	249 (8.5)	5481 (2.7)	782 (4.6)	698 (6.5)
Fairly significant (4-5)	16671 (7.5)	1061 (8.1)	246 (8.4)	14 782 (7.3)	1548 (9.1)	1032 (9.7)
No serious problem (6-8)	88 816 (40.1)	4832 (36.8)	830 (28.2)	81 106 (40.2)	6472 (38.1)	3774 (35.3)
No diagnosis (9)	98 997 (44.7)	5037 (38.4)	722 (24.5)	91 909 (45.6)	6260 (36.9)	3018 /28.3)
Ill-defined problem (1)	22 (0.0)	0 (0.0)	0 (0.0)	18 (0.0)	1 (0.0)	2 (0.0)
Stress resilience						
Low (1-3)	45 221 (20.4)	4407 (33.6)	1750 (59.4)	38 222 (19.0)	5927 (34.9)	5108 (47.8)
Moderate (4-6)	122 546 (55.3)	6092 (46.4)	1005 (34.1)	112 943 (56.0)	8227 (48.4)	4494 (42.1)
High (7-9)	53 767 (24.3)	2630 (20.0)	189 (6.4)	50 342 (25.0)	2829 (16.7)	1081 (10.1)
Education						
Compulsory	54 698 (24.7)	3634 (27.7)	1345 (45.7)	48 367 (24.0)	5254 (30.9)	4089 (38.3)
1-3 years post-compulsory	103 251 (46.6)	6595 (50.2)	1388 (47.1)	93 225 (46.3)	9019 (53.1)	5577 (52.2)
>3 years post-compulsory	63 585 (28.7)	2900 (22.1)	211 (7.2)	59 915 (29.7)	2710 (16.0)	1017 (9.5)
Height*	178.7 (6.4)	178.4 (6.5)	177.7 (6.7)	178.8 (6.4)	178.1 (6.5)	177.8 (6.6)
Physical working capacity*	6.3 (1.8)	6.0 (1.8)	5.6 (1.8)	6.4 (1.8)	6.0 (1.8)	5.8 (1.8)
Systolic blood pressure*	127.7(11.1)	127.0(11.1)	128.1 (11.3)	127.7 (11.1)	127.3(11.0)	127.8 (11.4)
Diastolic blood pressure*	71.6 (8.6)	71.7 (8.6)	73.0 (9.0)	71.6 (8.6)	71.8 (8.8)	72.3 (8.8)
Cognitive function*	5.2 (2.0)	5.0 (2.0)	3.82 (2.1)	5.3 (1.9)	4.7 (2.0)	4.1 (2.0)
Total *(row percentages)*	*221 534 (93.2)*	*13 129 (5.5)*	*2944 (1.2)*	*201 507 (87.9)*	*16 983 (7.4)*	*10 683(4.7)*

Table 2. Unemployment in 1990 and mortality risk (1990-2001) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	846 / 43 637	1.78 (1.67-1.91)	Ref.	Ref.	Ref.	Ref.
Unemployed	198 / 3206	5.87 (5.10-6.74)	3.33 (2.85-3.89)	2.43 (2.06-2.88)	2.40 (1.99-2.90)	2.25 (1.83-2.75)
Cognitive score 4-6						
Employed	1655 / 117 393	1.30 (1.24-1.36)	Ref.	Ref.	Ref.	Ref.
Unemployed	281 / 6799	3.96 (3.52-4.45)	3.08 (2.72-3.50)	2.33 (2.04-2.67)	2.50 (2.15-2.90)	2.33 (1.98-2.74)
Cognitive score 7-9						
Employed	604 / 60 504	0.92 (0.85-1.00)	Ref.	Ref.	Ref.	Ref.
Unemployed	67 / 3124	2.13 (1.68-2.71)	2.33 (1.81-3.00)	1.85 (1.42-2.40)	1.80 (1.33-2.43)	1.53 (1.08-2.16)
EDUCATION						
Compulsory education						
Employed	1015/54 698	1.71 (1.60-1.81)	Ref.	Ref.	Ref.	Ref.
Unemployed	208/3634	5.47 (4.78-6.27)	3.25 (2.80-3.77)	2.35 (1.99-2.76)	2.31 (1.93-2.76)	2.23 (1.83-2.72)
≤ 3 years post-compulsory education						
Employed	1524/103 251	1.36 (1.29-1.43)	Ref.	Ref.		
Unemployed	291/6595	4.21 (3.76-4.73)	3.14 (2.77-3.56)	2.25 (1.97-2.58)	2.40 (2.06-2.80)	2.19 (1.86-2.58)
> 3 years post-compulsory education						
Employed	566/63 585	0.83 (0.76-0.90)	Ref.	Ref.	Ref.	Ref.
Unemployed	47/2900	1.61 (1.21-2-15)	1.98 (1.47-2.66)	1.90 (1.40-2.57)	1.87 (1.32-2.66)	1.67 (1.13-2.46)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

Table 3. Unemployment in 2001 and mortality risk (2001-2010) stratified by level of cognitive function and education

	Number of events/ number of men	Mortality rates per 1000 person-years (95% CI)	Unadjusted[a] HR (95% CI)	Adjusted[b] HR (95% CI)	Excluding suicide[b] HR (95% CI)	Selection wearing off[b, c] HR (95% CI)
COGNITIVE FUNCTION						
Cognitive score 1-3						
Employed	790 / 37 222	2.65 (2.47 -2.84)	Ref.	Ref.	Ref.	Ref.
Unemployed	328 / 5008	8.41 (7.55-9.38)	3.19 (2.80-3.63)	2.76 (2.41-3.17)	2.80 (2.42-3.24)	2.64 (2.22-3.15)
Cognitive score 4-6						
Employed	1751 / 107 598	2.03 (1.94-2.13)	Ref.	Ref.	Ref.	Ref.
Unemployed	500 / 8783	7.35 (6.74-8.03)	3.63 (3.29-4.01)	3.03 (2.73-3.37)	3.03 (2.71-3.40)	2.73 (2.36-3.15)
Cognitive score 7-9						
Employed	759 / 56 687	1.67 /1.56-1.80)	Ref.	Ref.	Ref.	Ref.
Unemployed	143 / 3192	5.83 (4.95-6.86)	3.49 (2.92-4.18)	2.85(2.36-3.45)	2.91 (2.38-3.56)	3.02 (2.37-3.85)
EDUCATION						
Compulsory education						
Employed	1000/48 367	2.58 (2.43-2.75)	Ref.	Ref.	Ref.	Ref.
Unemployed	332/5254	8.17 (7.34-9.10)	3.18 (2.81-3.60)	2.81 (2.47-3.21)	2.84 (2.47-3.27)	2.67 (2.25-3.18)
≤ 3 years post-compulsory education						
Employed	1615/93 225	2.16 (2.06-2.27)	Ref.	Ref.	Ref.	Ref.
Unemployed	533/9019	7.61 (6.99-8.29)	3.54 (3.21-3.90)	2.87 (2.58-3.19)	2.91 (2.60-3.25)	2.67 (2.32-3.07)
> 3 years post-compulsory education						
Employed	685/59 915	1.43 (1.33 – 1.54)	Ref.	Ref.	Ref.	Ref.
Unemployed	106/2710	5.07 (4.19-6.13)	3.54 (2.88-4.34)	3.44 (2.78-4.25)	3.37 (2.68-4.23)	3.43 (2.58-4.54)

[a] Age is the underlying timescale.
[b] Adjusted for parental SEI in 1960, household crowding in 1960, height, BMI, systolic and diastolic blood pressure, physical capacity score, summary disease score, cognitive function score or attained education and region of residence.
[c] Deaths during the first four years of follow-up are excluded.
HR (95% CI): hazard ratio (and 95% confidence interval)
Ref: reference category

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	8, 15-16
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-8

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, explain how loss to follow-up was addressed	5-6, 8
		(*e*) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 9-11, 20
		(b) Give reasons for non-participation at each stage	5-6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5-6, 9-10, 20
		(b) Indicate number of participants with missing data for each variable of interest	6
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-11, 20-22
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-11, 21-22
		(*b*) Report category boundaries when continuous variables were categorized	6-8, 20-22
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11, 21-22
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-12

Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.