



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

Journal:	<i>BMJ Open</i>
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

SCHOLARONE™
Manuscripts

1
2
3 **Unemployment in later working life eliminates health potential associated with**
4 **cognition and education: Swedish register-based cohort study**
5
6

7 Scott Montgomery,^{1,2,3} Ruzan Udumyan,^{1,2} Anders Magnuson,¹ Walter Osika,⁴ Per-Ola
8 Sundin,^{2,5} David Blane⁶
9

- 10 1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85
11 Örebro, Sweden.
- 12 2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro,
13 Sweden.
- 14 3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Institutet, SE-
15 171 76 Stockholm, Sweden.
- 16 4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
- 17 5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
- 18 6. Department of Primary Care and Public Health, School of Public Health, Imperial
19 College London W6 8RP, UK.

20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35 **Correspondence:** Professor Scott Montgomery
36
37 Clinical Epidemiology and Biostatistics
38
39 S-Huset
40
41 Örebro University Hospital
42
43 701 85 Örebro
44
45 Sweden
46
47 Telephone +46 19 602 6210
48
49 scott.montgomery@orebroll.se
50
51

52
53 **Word count:** 242 (abstract); 3371 (text)
54
55
56
57
58
59
60

1
2
3 **Acknowledgements:** This study received support from Economic and Social Research
4 Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and
5 Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to
6 prepare the tables.
7
8
9
10

11
12
13
14 The study sponsors (ESRC and Örebro University) had no role in study design; in the
15 collection, analysis, and interpretation of data; in the writing of the report; or in the
16 decision to submit the article for publication.
17
18
19

20
21
22
23 SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM
24 prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and
25 clarified codes and measures required for the analysis. SM drafted the manuscript and
26 all contributors were involved in critical editing. SM will act as guarantor.
27
28
29
30
31

32
33
34 All authors have completed the Unified Competing Interest form at
35 www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro
36 University to support this work. None of the authors, their spouses, partners, or children
37 have financial or non-financial relationships that may be relevant to the submitted work.
38
39
40
41
42

43
44
45 Data sharing: no additional data available, as the ethical permission does not allow for
46 provision of data to individuals not in the research group.
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 paradox⁷

1
2
3 hypothesises that when individuals with greater potential and expectations encounter
4 economic adversity in adulthood the experience is relatively unexpected, resulting in
5 higher levels of stress and depression and thus also damage to other aspects of health.
6
7
8
9

10
11
12 Unexpected economic adversity even among those with greater personal resources may
13 be a particularly damaging at *older* ages,⁸ and obtaining another job at an equivalent
14 level more difficult. As the mechanisms linking cognitive function and education with
15 mortality may not be identical,² we examined these measures separately. This study
16 uses Swedish register data to examine associations of unemployment with mortality
17 among a cohort of men born between 1952 and 1956, to test the hypothesis that
18 unemployment disproportionately eliminates health potential associated with better
19 cognitive function and higher qualifications and that the effect varies by age.
20
21 Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and
22 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic
23 recession and another period of significant economic contraction was beginning in 2001.
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38

39 **Methods**

40 **Study population**

41
42 The cohort comprised all men born between 1st January 1952 and 31st December 1956
43 that were included in the Swedish Military Conscription Register.^{9 10} At this time the
44 majority of male Swedish citizens participated in the assessment for compulsory
45 military service that took place in late adolescence and fewer than 4% of men were not
46 involved due to chronic illness or disability. The assessments were between 1970 and
47 1975 and the majority at ages 18 and 19 years, with a small number after this time at
48
49
50
51
52
53
54
55
56
57
58
59
60
later ages. A total of 284,198 men were identified and 2,564 were excluded due to data

1
2
3 inconsistencies such as errors in the personal identification number, female sex or
4
5 uncertain vital status. We then excluded 225 men from the analysis with improbable
6
7 measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15
8
9 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230
10
11 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This
12
13 resulted in a sample of 272,768 men with data at the start of follow-up in December
14
15 1990. We then excluded 35,161 men with missing data for: census (18,178); education
16
17 (2,440); or the conscription assessments (28,483) that may have resulted from loss of
18
19 records. The sample available for the main analysis comprised 234,782 men.
20
21
22
23
24

25 **Measures**

26
27 The conscription examination in late adolescence provided the following measures.
28
29 Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic
30
31 blood pressure were measured after rest in recumbent men using a
32
33 sphygmomanometer. Physical working capacity was assessed using an electronically
34
35 braked ergometer for the maximum load sustained for six minutes, or an estimate
36
37 was derived from a nomogram for shorter duration. Cognitive testing covered four
38
39 domains: linguistic understanding (40 questions), spatial recognition (identifying
40
41 geometric shapes), general knowledge (40 questions) and ability to follow mechanical
42
43 instructions (problems presented as diagrams requiring knowledge of mechanics and
44
45 basic physics). The results of the cognitive function tests were transformed into a single
46
47 score with a value on a normalized standard scale ranging from 1 to 9. The conscripts
48
49 underwent a psychological examination to assess their potential ability to cope with
50
51 warfare and therefore providing an indication of their stress resilience, producing a
52
53 score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in
54
55
56
57
58
59
60

1
2
3 Swedish,¹¹ but it has been used in research reported in English.¹² The medical
4
5 assessment produced a score of 0 to 9 to indicate the severity of any medical problems,
6
7 such that 9 indicated no problem, with a decreasing score indicating increasing severity
8
9 to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-
10
11 defined problem (n=22).
12

13
14
15
16 Statistics Sweden provided socioeconomic and demographic data using the registers
17
18 they administer,¹³ including information on vital status and emigration from the Total
19
20 Population register. Childhood social and material circumstances were estimated using
21
22 data from the 1960 census, where the head of the household's occupation was
23
24 characterised as manual, agricultural, farm owners/managers, office workers, business
25
26 owners/managers, and others. The person per room ratio was divided into quarters of
27
28 its distribution. The Longitudinal database of Education, Income, and Occupation (LISA)
29
30 was used to obtain information on level of attained education in 1990, employment
31
32 status in 1985, as well employment status and receipt of disability/chronic disease
33
34 benefits in 1990 and 2001. Attained education - based on the duration of education
35
36 required for the qualification - was divided into three categories: compulsory (up to nine
37
38 years); up to three years post-compulsory; and over three years post-compulsory.
39
40 Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of
41
42 disability/chronic disease benefits at any time earlier in the year was recorded.
43
44
45
46
47
48
49

50 The Cause of Death Register¹⁴ provided ICD codes on causes of death, including for
51
52 suicide, where we also included undetermined intent as possible suicide.
53
54
55

56 57 **Statistical analysis** 58 59 60

1
2
3 Cox regression was used to examine the association of unemployment (compared with
4 employment) with subsequent mortality risk over two periods: unemployment in 1990
5 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who
6 received disability/chronic disease benefits at entry to either follow-up period were
7 excluded from analysis in that period. Follow-up was to death, emigration or the end of
8 the study period, whichever occurred first. The analysis was adjusted for socioeconomic
9 index of parents and household crowding in 1960, and the following conscription
10 measures: BMI in categories as in table 1, height (continuous), physical working
11 capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive
12 score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8,
13 and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the
14 later follow-up period) and region of residence. Attained age was used as the underlying
15 time-scale for all models to achieve the most efficient adjustment for age. The analyses
16 were stratified by the cognitive function score divided into equal thirds of its
17 distribution and then by the three-category education variable. Further analyses
18 excluded mortality due to suicide (including where the cause of death was recorded as
19 undetermined intent). Analyses then excluded the first four years of follow-up after
20 1990 and 2001 to allow for 'selection to wear off'.^{15 16}

21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46 A Cox regression model with follow-up over the entire study period (1990 to 2010)
47 assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for
48 the association with mortality for the combination of unemployment with cognitive
49 function or with education. Unemployment was modelled as a time-dependent covariate
50 and the analysis was adjusted for the potential confounding factors described above.
51
52
53
54
55
56
57
58
59
60

1
2
3 The statistical software used was Stata version 12/SE for Windows (StataCorp, College
4 Station, Texas). Tests were 2-sided and statistical significance was defined as $p < 0.05$ and
5 95% confidence intervals that do not include 1.00.
6
7
8
9

10 11 12 **Ethical permission**

13
14 Ethical permission to conduct this project was granted by the Uppsala Regional Ethics
15 Committee (Dnr 2009/306).
16
17
18
19

20 21 **Results**

22
23 All of the characteristics investigated were statistically significantly associated with
24 unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than
25 0.001, p values are not presented. Unemployment and receipt of a disability pension in
26 both periods were associated with lower parental SEI, greater household crowding, BMI
27 indicating underweight or obesity, diagnoses of more severe diseases at conscription,
28 low stress resilience, lower level qualifications, shorter stature, lower physical working
29 capacity, and lower cognitive function score. Higher diastolic blood pressure was
30 associated with unemployment and disability pension, but the pattern is more complex
31 for systolic blood pressure. The total number unemployed in 2001 was greater than in
32 1990 and the number on disability/chronic sickness benefit was notably greater in
33 2001. Overall, the distribution of educational attainment and cognitive function score
34 among the employed was very similar between the two periods, but a higher proportion
35 of those who experienced unemployment during the second period had lower
36 qualifications and cognitive function scores.
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 During the period 1990 to 2001, unemployment compared with employment in 1990
4 was associated with a statistically significantly raised risk of mortality in each of the
5 cognitive function and education strata, both before and after adjustment for the
6 potential confounding factors (table 2). Patterns of association for unemployment with
7 mortality are similar whether stratified by cognitive function or by education. The
8 results are graded by cognition and education, with the highest unemployment-related
9 mortality risk among men with the lowest cognitive function scores and education.
10 Exclusion of deaths due to suicide altered the gradient of risk between the first two
11 strata, but men with the highest cognitive function scores and qualifications remained at
12 lowest risk of mortality if they experienced unemployment. Some reduction in
13 magnitude of risk, but without loss of statistical significance, was observed when deaths
14 during the first four years of follow-up were excluded to allow for the 'wearing off' of
15 direct health selection.
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

34 During the period 2001 to 2010, unemployment compared with employment in 2001
35 was associated with a statistically significantly raised risk of mortality in each of the
36 education strata both before and after adjustment for the potential confounding factors
37 (table 3). Patterns of association for unemployment with mortality are similar whether
38 stratified by cognitive function or by education. In contrast with the earlier period, the
39 unemployment-related mortality risk, when stratified by cognition or education, is
40 reversed and consistently higher for the strata of those with the highest levels of
41 cognitive function or education. It is noteworthy that the absolute rate of
42 unemployment-related mortality is much more similar across the cognition and
43 education strata; even though there is more of a gradient among the employed. In all of
44 the adjusted models, after exclusion of death by suicide, and after allowing 'selection to
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 wear off, the gradient of unemployment-related mortality remains reversed or
4
5 eliminated compared with the earlier period: those with the higher level cognitive
6
7 function scores and qualifications had higher hazard ratios for mortality associated with
8
9 unemployment.
10

11
12
13
14 The interaction tests to assess effect modification by age/period are statistically
15
16 significant for both cognitive function ($p=0.004$) and education ($p=0.003$), consistent
17
18 with higher mortality among in men with better cognitive function or education when
19
20 they experience unemployment at a later age.
21
22
23

24 25 **Discussion**

26
27
28 Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was
29
30 associated with all-cause mortality: men with poorer cognitive function test scores and
31
32 lower-level educational attainment were at greater relative risk (measured by hazard
33
34 ratios) than men with higher qualifications. Unemployment in 2001 when the men were
35
36 aged 45 to 49 years was also associated with subsequent mortality, but the gradient was
37
38 reversed, such that the more intelligent and more highly qualified men were at greater
39
40 relative risk of mortality following unemployment. The gradient of absolute
41
42 unemployment-associated mortality rate, across cognition and education strata was
43
44 attenuated substantially by unemployment at an older age in 2001.
45
46
47
48
49

50
51 Previous research using data from the USA found that low income was a greater relative
52
53 risk for ischaemic heart disease and depression among individuals with markers of a
54
55 relatively privileged childhood and higher qualifications.^{5 7} Data from older adults in
56
57 Britain revealed that similar economic adversity eliminated the health potential for a
58
59
60

1
2
3 lower depression risk associated with markers of earlier advantage.⁶ We hypothesised
4
5 that this *unexpected* adversity results in a form of disappointment, thus increasing the
6
7 risk of disease through behavioural change and the systemic consequences of stress.
8
9 This study is an extension of the disappointment paradox concept but using longitudinal
10
11 rather than cross-sectional data. Unemployment at an older age among the more highly
12
13 qualified and those with higher cognitive function scores may represent a stressful
14
15 exposure that is more unexpected or more difficult to cope with than unemployment
16
17 experienced among men with fewer qualifications or lower cognitive function scores. As
18
19 we are concerned with unemployment as marker of socioeconomic adversity we did not
20
21 adjust for other contemporaneous economic measures collinear with unemployment.
22
23 The earlier research used diagnoses as the outcome⁵⁻⁷ and the results could theoretically
24
25 have been influenced by more highly educated individuals seeking health care: the use
26
27 of mortality in this study is not at similar risk of bias through health service use.
28
29
30
31
32
33

34
35 It has long been observed that suicide rates increase both during periods of economic
36
37 recession and also during phases of rapid economic growth; arguing that weakened
38
39 social norms, rather than poverty alone, reduces social cohesion and thus increases
40
41 suicide risk.¹⁷ A sense of coherence is relevant to an individual's adaptive capacity for
42
43 social stress¹⁸ and unemployment may be damaging in this respect. Those with higher
44
45 cognitive function and qualifications, signalling more advantages in earlier life, may be
46
47 less well adapted to coping with unemployment-related stress.^{6 7} This theoretical
48
49 framework not only potentially explains associations with suicide (the risk of which can
50
51 vary by age¹⁹), as our results are similar after exclusion of suicide. Poorer adaptation to
52
53 social adversity has also been linked to increased risk of stroke,²⁰ indicating effects on
54
55 the cardiovascular and possibly other systems.
56
57
58
59
60

1
2
3
4
5 Interaction analysis confirmed that the pattern of risk changed between the periods
6 such that the greater risk of mortality among men with better cognition and
7 qualifications who experienced unemployment at an older age was disproportionately
8 higher (a multiplicative effect). Older people who have less possibility to return to work
9 may find the consequence of the associated economic adversity more challenging,⁸
10 particularly during a period of economic contraction, despite the resources signalled by
11 higher cognition and qualifications. This unemployment-associated risk of ill health may
12 continue to increase with age.
13
14
15
16
17
18
19
20
21
22
23
24

25 Health selection can help to explain associations between unemployment and disease.²¹
26 Direct health selection is where pre-existing illness increases the risk of unemployment.
27 We tackled this by excluding men with disability and sickness benefits at study entry
28 and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we
29 excluded events (deaths) in the initial years of follow-up after unemployment to allow
30 selection to 'wear off' when a high proportion of those with the most serious diseases
31 pre-dating unemployment are expected to die,¹⁵ as used in other studies of
32 unemployment and mortality, including a previous study of unemployment in Sweden.¹⁶
33 The earlier Swedish study presented evidence of direct health selection as there was
34 statistically significant excess mortality in the first four years following unemployment
35 but not subsequently.¹⁶ Therefore we excluded the first four years of the follow-up in a
36 sub-analysis. Even though the men who experienced unemployment in the second
37 period of our study may have been more selected in terms of health, our procedures to
38 tackle direct selection make this unlikely as an explanation for the reversal of the
39 unemployment-mortality gradient by cognition or education.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 Indirect health selection is where personal characteristics linked with raised
6 unemployment risk are also risks for poor health.^{21 22} We adjusted for a variety of
7 measures relevant to future health and mortality risk, including chronic illnesses,
8 height,²³ blood pressure,⁹ BMI,^{24 25} cognition,^{2 3} markers of physical fitness²⁵ and stress
9 resilience. Men with the most severe disabilities or chronic illness preventing military
10 service would not have undergone some of the tests at conscription and are thus not
11 included in the analysis. Indirect health selection is unlikely to explain the
12 disappearance at a later age of the relatively protective association with higher
13 qualifications and cognition, as the opposite effect might be expected.
14
15
16
17
18
19
20
21
22
23
24
25
26
27

28 It should be emphasised that unemployment remained less common among the more
29 highly educated men and those with higher cognitive function. This means that support
30 and benefits will remain a bigger issue for the less highly qualified and more
31 disadvantaged. Unemployment can result in persistent disadvantage, including through
32 subsequent unstable employment,²⁶⁻²⁸ so when experienced at an earlier age it can
33 cause harm across an entire adult life. While it remains possible that earlier exit from
34 the labour market helps to explain these results, it does not alter the fact that
35 unemployment among older men is relatively more damaging across the social
36 spectrum, suggesting this is a 'critical period' where interventions might be focused.²⁹
37
38
39
40
41
42
43
44
45
46
47
48
49

50 The experience of unemployment can contribute to the risk of ill-health through several
51 mechanisms.¹ Behavioural change following unemployment, such as increases in
52 smoking (or failure to give up) and an unhealthy diet²⁶ can increase the risk of
53 cardiovascular disease and cancer. The financial disadvantage associated with
54
55
56
57
58
59
60

1
2
3 unemployment can persist even after finding a new job²⁶ and the association of poverty
4 with mortality is well known.³⁰ Depression and stress resulting from unemployment is
5 also likely to be relevant, as this has may raise mortality risk through behavioural and
6 possibly systemic mechanisms.³¹ Stressful events and circumstances have been linked
7 to an increase in mortality due to suicide and cardiovascular disease.³² The mechanisms
8 linking cognitive function and education with mortality may not be identical,² but the
9 pattern of unemployment-related mortality risk is similar when stratified by cognition
10 or education.
11
12
13
14
15
16
17
18
19

20 21 22 23 **Limitations**

24
25 Potential limitations of the study include its inclusion of only men. This was necessary as
26 the detailed baseline data on health and function were collected during military
27 conscription, which at the time was only available to men. Disentangling age and period
28 effects in a single cohort can be problematic. The two time points differed in
29 unemployment rate: the proportion unemployed was larger in the second period, thus
30 possibly altering selection effects. To tackle possible selection bias we adjusted for
31 multiple markers of susceptibility. We also excluded events during the first part of the
32 follow-up period to allow direct health selection to 'wear off'. The study focused on
33 unemployment only at two time points and these represent times when Sweden was
34 entering periods of economic contraction: these were chosen when the study was
35 designed and information on unemployment at other times was not included in our
36 dataset. These measures will underestimate the experience of unemployment and does
37 not take duration of unemployment into account. This is likely to make our estimates
38 less precise rather than creating spurious results. The focus of the study was on
39 mortality as an objective endpoint. While this will underestimate the damage to health
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 associated with unemployment substantially, it makes it more feasible to tackle the
4 effects of direct health selection, as less serious health events that could influence
5 unemployment risk will not contribute so notably to mortality in the first years
6 following unemployment that we excluded from the 'selection wearing off' analysis.
7
8 Mortality is more likely to occur at older ages and causes of mortality vary by age.
9
10
11
12

13
14
15
16 Unemployment during periods of economic contraction is associated with raised
17 mortality that may not be explained fully by direct or indirect health selection into
18 unemployment. With increasing age, the experience of unemployment may be
19 unexpectedly harmful to those with better cognition, higher qualifications and
20 associated resources. This highlights the importance of supporting the entire population
21 who experience unemployment during a recession and the greater vulnerability of older
22 workers, irrespective of their health potential indicated by markers of protection such as
23 cognitive function and education.
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 health 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:	<i>BMJ Open</i>
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

SCHOLARONE™
Manuscripts

only

1
2
3 **Mortality following unemployment during an economic downturn: Swedish**
4 **register-based cohort study**
5

6
7 Scott Montgomery,^{1,2,3} Ruzan Udumyan,^{1,2} Anders Magnuson,¹ Walter Osika,⁴ Per-Ola
8 Sundin,^{2,5} David Blane⁶
9

- 10
11 1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85
12 Örebro, Sweden.
13
14 2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro,
15 Sweden.
16
17 3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Insitutet, SE-
18 171 76 Stockholm, Sweden.
19
20 4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
21
22 5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
23
24 6. Department of Primary Care and Public Health, School of Public Health, Imperial
25 College London W6 8RP, UK.
26
27
28
29
30
31
32
33
34

35 **Correspondence:** Professor Scott Montgomery
36
37 Clinical Epidemiology and Biostatistics
38
39 S-huset
40
41 Örebro University Hospital
42
43 701 85 Örebro
44
45 Sweden
46
47 Telephone +46 19 602 6210
48
49 scott.montgomery@orebroll.se
50
51

52
53 **Word count:** 296 (abstract); 3421 (text)
54
55
56
57
58
59
60

1
2
3 **Acknowledgements:** This study received support from Economic and Social Research
4 Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and
5 Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to
6 prepare the tables.
7
8
9
10

11
12
13
14 The study sponsors (ESRC and Örebro University) had no role in study design; in the
15 collection, analysis, and interpretation of data; in the writing of the report; or in the
16 decision to submit the article for publication.
17
18
19

20
21
22
23 SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM
24 prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and
25 clarified codes and measures required for the analysis. SM drafted the manuscript and
26 all contributors were involved in critical editing. SM will act as guarantor.
27
28
29
30
31

32
33
34 All authors have completed the Unified Competing Interest form at
35 www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro
36 University to support this work. None of the authors, their spouses, partners, or children
37 have financial or non-financial relationships that may be relevant to the submitted work.
38
39
40
41
42

43
44
45 Data sharing: no additional data available, as the ethical permission does not allow for
46 provision of data to individuals not in the research group.
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 health 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
2
3 (1.99 to 2.76) for compulsory education, 2.25 (1.97 to 2.58) for up to three years post-
4 compulsory education and 1.90 (1.40 to 2.57) for more than three years post-
5 compulsory education. When unemployment was compared with employment in 2001
6 compulsory education. When unemployment was compared with employment in 2001
7 (ages 45 to 49 years) with follow-up to 2010, the pattern of mortality risk (4271 deaths)
8 stratified by education was reversed, producing adjusted hazard ratios of 2.81 (2.47 to
9 3.21) for compulsory education, 2.87 (2.58 to 3.19) for up to three years post-
10 compulsory education and 3.44 (2.78 to 4.25) for more than three years post-
11 compulsory education. Interaction testing confirmed effect modification by age/period
12 (p=0.003). The degree of gradient reversal was slightly less pronounced after
13 stratification by cognitive function but produced a similar pattern of results (p =0.004).

14
15
16
17
18
19
20
21
22
23
24
25
26 **Conclusions** Unemployment at older ages is associated with greater mortality risk than
27 at younger ages, with the greatest relative increase in risk among men with markers of
28 better health, suggesting the greater vulnerability of all older workers to
29 unemployment-associated exposures.
30
31
32
33
34
35
36
37
38
39

40 **Introduction**

41
42 Economic recession and associated austerity measures result in increased
43 unemployment, which is linked with poorer health and excess mortality through a
44 variety of mechanisms.¹ During a recession, unemployment may be experienced by a
45 broader spectrum of the working population rather than just more disadvantaged
46 individuals. Does this atypical pattern of exposure to unemployment have unexpected
47 health consequences?
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Better cognitive function and higher levels of education are associated with better health
4 and reduced mortality risk in later life.²⁻⁴ A review of intelligence in youth and all-cause
5 mortality highlighted the likely importance of economic and social characteristics in
6 adulthood in explaining the association.³ Further clarification may be gained by
7 examining how economic disadvantage such as unemployment modifies the association
8 of intelligence in adolescence with adult mortality risk.
9
10
11
12
13
14
15
16
17
18

19 Better cognitive function and educational attainment confer protection against
20 unemployment and facilitate a more rapid transition back to employment from
21 unemployment, thus reducing the duration of exposure to unemployment-associated
22 adversity. Therefore, health following experience of unemployment should be better
23 among those with better cognitive function and the more highly qualified. However, in
24 earlier studies we demonstrated that *unexpected* financial adversity is
25 disproportionately damaging to health,⁵⁻⁷ where adult economic disadvantage was
26 experienced among those with pre-existing markers of better health and economic
27 potential signalled by markers of childhood advantage. The disappointment paradox⁷
28 hypothesises that when individuals with greater potential and expectations encounter
29 economic adversity in adulthood the experience is relatively unexpected, resulting in
30 higher levels of stress and depression and thus also damage to other aspects of health.
31 This is consistent with the finding that psychological distress associated with
32 unemployment was reported more frequently reported among white-collar than blue-
33 collar workers.⁸
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51

52
53
54
55 Unexpected economic adversity even among those with greater personal resources may
56 be a particularly damaging at *older* ages,⁹ and obtaining another job at an equivalent
57
58
59
60

1
2
3 level more difficult. As the mechanisms linking cognitive function and education with
4 mortality may not be identical,² we examined these measures separately. This study
5 uses Swedish register data to examine associations of unemployment with mortality
6 among a cohort of men born between 1952 and 1956, to test the hypothesis that
7 unemployment disproportionately eliminates health potential associated with better
8 cognitive function and higher qualifications and that the effect varies by age.
9 Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and
10 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic
11 recession and another period of significant economic contraction was beginning in 2001.
12
13
14
15
16
17
18
19
20
21
22
23
24

25 **Methods**

26 **Study population**

27
28 The cohort comprised all men born between 1st January 1952 and 31st December 1956
29 that were included in the Swedish Military Conscription Register.^{10 11} At this time the
30 majority of male Swedish citizens participated in the assessment for compulsory
31 military service that took place in late adolescence and fewer than 4% of men were not
32 involved due to chronic illness or disability. The assessments were between 1970 and
33 1975 and the majority at ages 18 and 19 years, with a small number after this time at
34 later ages. A total of 284,198 men were identified and 2,564 were excluded due to data
35 inconsistencies such as errors in the personal identification number, female sex or
36 uncertain vital status. We then excluded 225 men from the analysis with improbable
37 measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15
38 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230
39 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This
40 resulted in a sample of 272,768 men with data at the start of follow-up in December
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 1990. We then excluded 35,161 men with missing data for: census (18,178); education
4 (2,440); or the conscription assessments (28,483) that may have resulted from loss of
5 records. The sample available for the main analysis comprised 234,782 men.
6
7
8
9

10 11 12 **Measures**

13
14 The conscription examination in late adolescence provided the following measures.
15 Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic
16 blood pressure were measured after rest in recumbent men using a
17 sphygmomanometer. Physical working capacity was assessed using an electronically
18 braked ergometer for the maximum load sustained for six minutes, or an estimate
19 was derived from a nomogram for shorter duration. Cognitive testing covered four
20 domains: linguistic understanding (40 questions), spatial recognition (identifying
21 geometric shapes), general knowledge (40 questions) and ability to follow mechanical
22 instructions (problems presented as diagrams requiring knowledge of mechanics and
23 basic physics). The results of the cognitive function tests were transformed into a single
24 score with a value on a normalized standard scale ranging from 1 to 9. The conscripts
25 underwent a psychological examination to assess their potential ability to cope with
26 warfare and therefore providing an indication of their stress resilience, producing a
27 score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in
28 Swedish,¹² but it has been used in research reported in English.¹³ The medical
29 assessment produced a score of 0 to 9 to indicate the severity of any medical problems,
30 such that 9 indicated no problem, with a decreasing score indicating increasing severity
31 to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-
32 defined problem (n=22).
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Statistics Sweden provided socioeconomic and demographic data using the registers
4 they administer,¹⁴ including information on vital status and emigration from the Total
5 Population register. Childhood social and material circumstances were estimated using
6 data from the 1960 census, where the head of the household's occupation was
7 characterised as manual, agricultural, farm owners/managers, office workers, business
8 owners/managers, and others. The person per room ratio was divided into quarters of
9 its distribution. The Longitudinal database of Education, Income, and Occupation (LISA)
10 was used to obtain information on level of attained education in 1990, employment
11 status in 1985, as well employment status and receipt of disability/chronic disease
12 benefits in 1990 and 2001. Attained education - based on the duration of education
13 required for the qualification - was divided into three categories: compulsory (up to nine
14 years); up to three years post-compulsory; and over three years post-compulsory.
15 Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of
16 disability/chronic disease benefits at any time earlier in the year was recorded.
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

37 The Cause of Death Register¹⁵ provided ICD codes on causes of death, including for
38 suicide, where we also included undetermined intent as possible suicide.
39
40
41
42

43 **Statistical analysis**

44
45
46 Cox regression was used to examine the association of unemployment (compared with
47 employment) with subsequent mortality risk over two periods: unemployment in 1990
48 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who
49 received disability/chronic disease benefits at entry to either follow-up period were
50 excluded from analysis in that period. Follow-up was to death, emigration or the end of
51 the study period, whichever occurred first. The analysis was adjusted for socioeconomic
52
53
54
55
56
57
58
59
60

1
2
3 index of parents and household crowding in 1960, and the following conscription
4
5 measures: BMI in categories as in table 1, height (continuous), physical working
6
7 capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive
8
9 score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8,
10
11 and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the
12
13 later follow-up period) and region of residence. Attained age was used as the underlying
14
15 time-scale for all models to achieve the most efficient adjustment for age. The analyses
16
17 were stratified by the cognitive function score divided into equal thirds of its
18
19 distribution and then by the three-category education variable. Further analyses
20
21 excluded mortality due to suicide (including where the cause of death was recorded as
22
23 undetermined intent). Analyses then excluded the first four years of follow-up after
24
25 1990 and 2001 to allow for 'selection to wear off'.^{16 17}
26
27
28
29
30
31

32 A Cox regression model with follow-up over the entire study period (1990 to 2010)
33
34 assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for
35
36 the association with mortality for the combination of unemployment with cognitive
37
38 function or with education. Unemployment was modelled as a time-dependent covariate
39
40 and the analysis was adjusted for the potential confounding factors described above.
41
42
43
44
45

46 The statistical software used was Stata version 12/SE for Windows (StataCorp, College
47
48 Station, Texas). Tests were 2-sided and statistical significance was defined as $p < 0.05$ and
49
50 95% confidence intervals that do not include 1.00.
51
52
53
54

55 **Ethical permission**

56
57
58
59
60

1
2
3 Ethical permission to conduct this project was granted by the Uppsala Regional Ethics
4
5 Committee (Dnr 2009/306).
6
7
8

9 10 **Results**

11 All of the characteristics investigated were statistically significantly associated with
12 unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than
13
14 0.001, p values are not presented. Unemployment and receipt of a disability pension in
15
16 both periods were associated with lower parental SEI, greater household crowding, BMI
17
18 indicating underweight or obesity, diagnoses of more severe diseases at conscription,
19
20 low stress resilience, lower level qualifications, shorter stature, lower physical working
21
22 capacity, and lower cognitive function score. Higher diastolic blood pressure was
23
24 associated with unemployment and disability pension, but the pattern is more complex
25
26 for systolic blood pressure. The total number unemployed in 2001 was greater than in
27
28 1990 and the number on disability/chronic sickness benefit was notably greater in
29
30 2001. Overall, the distribution of educational attainment and cognitive function score
31
32 among the employed was very similar between the two periods, but a higher proportion
33
34 of those who experienced unemployment during the second period had lower
35
36 qualifications and cognitive function scores.
37
38
39
40
41
42
43
44
45

46 During the period 1990 to 2001, unemployment compared with employment in 1990
47
48 was associated with a statistically significantly raised risk of mortality in each of the
49
50 cognitive function and education strata, both before and after adjustment for the
51
52 potential confounding factors (table 2). Patterns of association for unemployment with
53
54 mortality are similar whether stratified by cognitive function or by education. The
55
56 results are graded by cognition and education, with the highest unemployment-related
57
58
59
60

1
2
3 mortality risk among men with the lowest cognitive function scores and education.
4
5 Exclusion of deaths due to suicide altered the gradient of risk between the first two
6
7 strata, but men with the highest cognitive function scores and qualifications remained at
8
9 lowest risk of mortality if they experienced unemployment. Some reduction in
10
11 magnitude of risk, but without loss of statistical significance, was observed when deaths
12
13 during the first four years of follow-up were excluded to allow for the 'wearing off' of
14
15 direct health selection.
16
17

18
19
20 During the period 2001 to 2010, unemployment compared with employment in 2001
21
22 was associated with a statistically significantly raised risk of mortality in each of the
23
24 education strata both before and after adjustment for the potential confounding factors
25
26 (table 3). Patterns of association for unemployment with mortality are similar whether
27
28 stratified by cognitive function or by education. In contrast with the earlier period, the
29
30 unemployment-related mortality risk, when stratified by cognition or education, is
31
32 reversed and consistently higher for the strata of those with the highest levels of
33
34 cognitive function or education. It is noteworthy that the absolute rate of
35
36 unemployment-related mortality is much more similar across the cognition and
37
38 education strata; even though there is more of a gradient among the employed. In all of
39
40 the adjusted models, after exclusion of death by suicide, and after allowing 'selection to
41
42 wear off', the gradient of unemployment-related mortality remains reversed or
43
44 eliminated compared with the earlier period: those with the higher level cognitive
45
46 function scores and qualifications had higher hazard ratios for mortality associated with
47
48 unemployment.
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 The interaction tests to assess effect modification by age/period are statistically
4 significant for both cognitive function ($p=0.004$) and education ($p=0.003$), consistent
5 with higher mortality among in men with better cognitive function or education when
6 they experience unemployment at a later age.
7
8
9
10

11 Discussion

12
13
14 Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was
15 associated with all-cause mortality: men with poorer cognitive function test scores and
16 lower-level educational attainment were at greater relative risk (measured by hazard
17 ratios) than men with higher qualifications. Unemployment in 2001 when the men were
18 aged 45 to 49 years was also associated with subsequent mortality, but the gradient was
19 reversed, such that the more intelligent and more highly qualified men were at greater
20 relative risk of mortality following unemployment. The gradient of absolute
21 unemployment-associated mortality rate, across cognition and education strata was
22 attenuated substantially by unemployment at an older age in 2001.
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38

39 Previous research using data from the USA found that low income was a greater relative
40 risk for ischaemic heart disease and depression among individuals with markers of a
41 relatively privileged childhood and higher qualifications.^{5 7} Data from older adults in
42 Britain revealed that similar economic adversity eliminated the lower depression risk
43 associated with markers of earlier advantage.⁶ We hypothesised that this *unexpected*
44 adversity results in a form of disappointment, thus increasing the risk of disease through
45 behavioural change and the systemic consequences of stress. This study is an extension
46 of the disappointment paradox concept but using longitudinal rather than cross-
47 sectional data. Unemployment at an older age among the more highly qualified and
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 those with higher cognitive function scores may represent a stressful exposure that is
4
5 more unexpected or more difficult to cope with than unemployment experienced among
6
7 men with fewer qualifications or lower cognitive function scores, as suggested by the
8
9 higher levels of unemployment-related psychological distress observed among white-
10
11 collar workers.⁸ As we are concerned with unemployment as marker of socioeconomic
12
13 adversity we did not adjust for other contemporaneous economic measures collinear
14
15 with unemployment. The earlier research used diagnoses as the outcome⁵⁻⁷ and the
16
17 results could theoretically have been influenced by more highly educated individuals
18
19 seeking health care: the use of mortality in this study is not at similar risk of bias
20
21 through health service use.
22
23
24
25
26
27

28 It has long been observed that suicide rates increase both during periods of economic
29
30 recession and also during phases of rapid economic growth; arguing that weakened
31
32 social norms, rather than poverty alone, reduces social cohesion and thus increases
33
34 suicide risk.¹⁸ A sense of coherence is relevant to an individual's adaptive capacity for
35
36 social stress¹⁹ and unemployment may be damaging in this respect. Those with higher
37
38 cognitive function and qualifications, signalling more advantages in earlier life, may be
39
40 less well adapted to coping with unemployment-related stress.^{6 7} This theoretical
41
42 framework not only potentially explains associations with suicide (the risk of which can
43
44 vary by age²⁰), as our results are similar after exclusion of suicide. Poorer adaptation to
45
46 social adversity has also been linked to increased risk of stroke,²¹ indicating effects on
47
48 the cardiovascular and possibly other systems.
49
50
51
52
53
54

55 Interaction analysis confirmed that the pattern of risk changed between the periods
56
57 such that the greater risk of mortality among men with better cognition and
58
59
60

1
2
3 qualifications who experienced unemployment at an older age was disproportionately
4 higher (a multiplicative effect). Older people who have less possibility to return to work
5 may find the consequence of the associated economic adversity more challenging,⁹
6 particularly during a period of economic contraction, despite the resources signalled by
7 higher cognition and qualifications. This unemployment-associated risk of ill health may
8 continue to increase with age.
9
10
11
12
13
14
15
16
17
18

19 Health selection can help to explain associations between unemployment and disease.²²
20 Direct health selection is where pre-existing illness increases the risk of unemployment.
21 We tackled this by excluding men with disability and sickness benefits at study entry
22 and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we
23 excluded events (deaths) in the initial years of follow-up after unemployment to allow
24 selection to 'wear off' when a high proportion of those with the most serious diseases
25 pre-dating unemployment are expected to die,¹⁶ as used in other studies of
26 unemployment and mortality, including a previous study of unemployment in Sweden.¹⁷
27 The earlier Swedish study presented evidence of direct health selection as there was
28 statistically significant excess mortality in the first four years following unemployment
29 but not subsequently.¹⁷ Therefore we excluded the first four years of the follow-up in a
30 sub-analysis. Even though the men who experienced unemployment in the second
31 period of our study may have been more selected in terms of health, our procedures to
32 tackle direct selection make this unlikely as an explanation for the reversal of the
33 unemployment-mortality gradient by cognition or education.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54

55 Indirect health selection is where personal characteristics linked with raised
56 unemployment risk are also risks for poor health.^{22 23} We adjusted for a variety of
57
58
59
60

1
2
3 measures relevant to future health and mortality risk, including chronic illnesses,
4 height,²⁴ blood pressure,¹⁰ BMI,^{25 26} cognition,^{2 3} markers of physical fitness²⁶ and stress
5
6
7 resilience. Men with the most severe disabilities or chronic illness preventing military
8
9
10 service would not have undergone some of the tests at conscription and are thus not
11
12 included in the analysis. Indirect health selection is unlikely to explain the
13
14 disappearance at a later age of the relatively protective association with higher
15
16 qualifications and cognition, as the opposite effect might be expected.
17
18

19
20
21 It should be emphasised that unemployment remained less common among the more
22
23 highly educated men and those with higher cognitive function. This means that support
24
25 and benefits will remain a bigger issue for the less highly qualified and more
26
27 disadvantaged. Unemployment can result in persistent disadvantage, including through
28
29 subsequent unstable employment,²⁷⁻²⁹ so when experienced at an earlier age it can
30
31 cause harm across an entire adult life. While it remains possible that earlier exit from
32
33 the labour market helps to explain these results, it does not alter the fact that
34
35 unemployment among older men is relatively more damaging across the social
36
37 spectrum, suggesting this is a 'critical period' where interventions might be focused.³⁰
38
39
40
41
42

43
44 The experience of unemployment can contribute to the risk of ill-health through several
45
46 mechanisms.¹ Behavioural change following unemployment, such as increases in
47
48 smoking (or failure to give up) and an unhealthy diet²⁷ can increase the risk of
49
50 cardiovascular disease and cancer. The financial disadvantage associated with
51
52 unemployment can persist even after finding a new job²⁷ and the association of poverty
53
54 with mortality is well known.³¹ Depression and stress resulting from unemployment is
55
56 also likely to be relevant, as this has may raise mortality risk through behavioural and
57
58
59
60

1
2
3 possibly systemic mechanisms.³² Stressful events and circumstances have been linked
4
5 to an increase in mortality due to suicide and cardiovascular disease.³³ The mechanisms
6
7 linking cognitive function and education with mortality may not be identical,² but the
8
9 pattern of unemployment-related mortality risk is similar when stratified by cognition
10
11 or education.
12

13 14 15 16 17 **Limitations**

18
19 Potential limitations of the study include its inclusion of only men, as women can also be
20
21 affected adversely by unemployment. This was necessary as the detailed baseline data
22
23 on health and function were collected during military conscription, which at the time
24
25 was only available to men. Disentangling age and period effects in a single cohort can be
26
27 problematic. The two time points differed in unemployment rate: the proportion
28
29 unemployed was larger in the second period, thus possibly altering selection effects. To
30
31 tackle possible selection bias we adjusted for multiple markers of susceptibility. We also
32
33 excluded events during the first part of the follow-up period to allow direct health
34
35 selection to 'wear off'. The study focused on unemployment only at two time points and
36
37 these represent times when Sweden was entering periods of economic contraction:
38
39 these were chosen when the study was designed and information on unemployment at
40
41 other times was not included in our dataset. These measures will underestimate the
42
43 experience of unemployment and does not take duration of unemployment into account.
44
45 This is likely to make our estimates less precise rather than creating spurious results.
46
47 There is a greater possibility of prior unemployment in the later period and thus greater
48
49 unemployment duration, but our adjustment for previous unemployment did not
50
51 indicate that this was driving the results. The focus of the study was on mortality as an
52
53 objective endpoint. While this will underestimate the damage to health associated with
54
55
56
57
58
59
60

1
2
3 unemployment substantially, it makes it more feasible to tackle the effects of direct
4
5 health selection, as less serious health events that could influence unemployment risk
6
7 will not contribute so notably to mortality in the first years following unemployment
8
9 that we excluded from the 'selection wearing off' analysis. Mortality is more likely to
10
11 occur at older ages and causes of mortality vary by age.
12
13

14
15
16 Unemployment during periods of economic contraction is associated with raised
17
18 mortality that may not be explained fully by direct or indirect health selection into
19
20 unemployment. With increasing age, the experience of unemployment may be
21
22 unexpectedly harmful to those with better cognition, higher qualifications and
23
24 associated resources. This highlights the importance of supporting the entire population
25
26 who experience unemployment during a recession and the greater vulnerability of older
27
28 workers.
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

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

1
2
3 **Mortality following unemployment during an economic downturn: Swedish**
4 **register-based cohort study**
5

6
7 Scott Montgomery,^{1,2,3} Ruzan Udumyan,^{1,2} Anders Magnuson,¹ Walter Osika,⁴ Per-Ola
8 Sundin,^{2,5} David Blane⁶
9

- 10
11 1. Clinical Epidemiology and Biostatistics, Örebro University Hospital, SE-701 85
12 Örebro, Sweden.
- 13
14 2. School of Health and Medical Sciences, Örebro University, SE-701 83 Örebro,
15 Sweden.
- 16
17 3. Clinical Epidemiology Unit, Karolinska University Hospital, Karolinska Insitutet, SE-
18 171 76 Stockholm, Sweden.
- 19
20 4. Stress Research Institute, Stockholm University, SE-106 91 Stockholm, Sweden.
- 21
22 5. Department of Medicine, Örebro University Hospital, SE-701 85 Örebro, Sweden.
- 23
24 6. Department of Primary Care and Public Health, School of Public Health, Imperial
25 College London W6 8RP, UK.

26
27
28
29
30
31
32
33
34
35 **Correspondence:** Professor Scott Montgomery
36
37 Clinical Epidemiology and Biostatistics
38
39 S-huset
40
41 Örebro University Hospital
42
43 701 85 Örebro
44
45 Sweden
46
47 Telephone +46 19 602 6210
48
49 scott.montgomery@orebroll.se
50
51

52
53 **Word count:** 296 (abstract); 3421 (text)
54
55
56
57
58
59
60

1
2
3 **Acknowledgements:** This study received support from Economic and Social Research
4 Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and
5 Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to
6 prepare the tables.
7
8
9
10

11
12
13
14 The study sponsors (ESRC and Örebro University) had no role in study design; in the
15 collection, analysis, and interpretation of data; in the writing of the report; or in the
16 decision to submit the article for publication.
17
18
19

20
21
22
23 SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM
24 prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and
25 clarified codes and measures required for the analysis. SM drafted the manuscript and
26 all contributors were involved in critical editing. SM will act as guarantor.
27
28
29
30

31
32
33
34 All authors have completed the Unified Competing Interest form at
35 www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro
36 University to support this work. None of the authors, their spouses, partners, or children
37 have financial or non-financial relationships that may be relevant to the submitted work.
38
39
40
41
42

43
44
45
46 Data sharing: no additional data available, as the ethical permission does not allow for
47 provision of data to individuals not in the research group.
48
49
50
51
52
53
54
55
56
57
58
59
60

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 health 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
2
3 (1.99 to 2.76) for compulsory education, 2.25 (1.97 to 2.58) for up to three years post-
4 compulsory education and 1.90 (1.40 to 2.57) for more than three years post-
5 compulsory education. When unemployment was compared with employment in 2001
6 compulsory education. When unemployment was compared with employment in 2001
7 (ages 45 to 49 years) with follow-up to 2010, the pattern of mortality risk (4271 deaths)
8 stratified by education was reversed, producing adjusted hazard ratios of 2.81 (2.47 to
9 3.21) for compulsory education, 2.87 (2.58 to 3.19) for up to three years post-
10 compulsory education and 3.44 (2.78 to 4.25) for more than three years post-
11 compulsory education. Interaction testing confirmed effect modification by age/period
12 (p=0.003). The degree of gradient reversal was slightly less pronounced after
13 stratification by cognitive function but produced a similar pattern of results (p =0.004).

14
15
16
17
18
19
20
21
22
23
24
25 **Conclusions** Unemployment at older ages is associated with greater mortality risk than
26 at younger ages, with the greatest relative increase in risk among men with markers of
27 better health, suggesting the greater vulnerability of all older workers to
28 unemployment-associated exposures.
29
30
31
32
33
34
35
36
37
38
39

40 Introduction

41
42 Economic recession and associated austerity measures result in increased
43 unemployment, which is linked with poorer health and excess mortality through a
44 variety of mechanisms.¹ During a recession, unemployment may be experienced by a
45 broader spectrum of the working population rather than just more disadvantaged
46 individuals. Does this atypical pattern of exposure to unemployment have unexpected
47 health consequences?
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Better cognitive function and higher levels of education are associated with better health
4 and reduced mortality risk in later life.²⁻⁴ A review of intelligence in youth and all-cause
5 mortality highlighted the likely importance of economic and social characteristics in
6 adulthood in explaining the association.³ Further clarification may be gained by
7 examining how economic disadvantage such as unemployment modifies the association
8 of intelligence in adolescence with adult mortality risk.
9
10
11
12
13
14
15
16
17
18

19 Better cognitive function and educational attainment confer protection against
20 unemployment and facilitate a more rapid transition back to employment from
21 unemployment, thus reducing the duration of exposure to unemployment-associated
22 adversity. Therefore, health following experience of unemployment should be better
23 among those with better cognitive function and the more highly qualified. However, in
24 earlier studies we demonstrated that *unexpected* financial adversity is
25 disproportionately damaging to health,⁵⁻⁷ where adult economic disadvantage was
26 experienced among those with pre-existing markers of better health and economic
27 potential signalled by markers of childhood advantage. The disappointment paradox⁷
28 hypothesises that when individuals with greater potential and expectations encounter
29 economic adversity in adulthood the experience is relatively unexpected, resulting in
30 higher levels of stress and depression and thus also damage to other aspects of health.
31 This is consistent with the finding that psychological distress associated with
32 unemployment was reported more frequently reported among white-collar than blue-
33 collar workers.⁸
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51

52
53
54
55 Unexpected economic adversity even among those with greater personal resources may
56 be a particularly damaging at *older* ages,⁹ and obtaining another job at an equivalent
57
58
59
60

1
2
3 level more difficult. As the mechanisms linking cognitive function and education with
4 mortality may not be identical,² we examined these measures separately. This study
5 uses Swedish register data to examine associations of unemployment with mortality
6 among a cohort of men born between 1952 and 1956, to test the hypothesis that
7 unemployment disproportionately eliminates health potential associated with better
8 cognitive function and higher qualifications and that the effect varies by age.
9 Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and
10 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic
11 recession and another period of significant economic contraction was beginning in 2001.
12
13
14
15
16
17
18
19
20
21
22
23
24

25 **Methods**

26 **Study population**

27
28 The cohort comprised all men born between 1st January 1952 and 31st December 1956
29 that were included in the Swedish Military Conscription Register.^{10 11} At this time the
30 majority of male Swedish citizens participated in the assessment for compulsory
31 military service that took place in late adolescence and fewer than 4% of men were not
32 involved due to chronic illness or disability. The assessments were between 1970 and
33 1975 and the majority at ages 18 and 19 years, with a small number after this time at
34 later ages. A total of 284,198 men were identified and 2,564 were excluded due to data
35 inconsistencies such as errors in the personal identification number, female sex or
36 uncertain vital status. We then excluded 225 men from the analysis with improbable
37 measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15
38 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230
39 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This
40 resulted in a sample of 272,768 men with data at the start of follow-up in December
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 1990. We then excluded 35,161 men with missing data for: census (18,178); education
4 (2,440); or the conscription assessments (28,483) that may have resulted from loss of
5 records. The sample available for the main analysis comprised 234,782 men.
6
7
8
9

10 11 12 **Measures**

13
14 The conscription examination in late adolescence provided the following measures.
15 Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic
16 blood pressure were measured after rest in recumbent men using a
17 sphygmomanometer. Physical working capacity was assessed using an electronically
18 braked ergometer for the maximum load sustained for six minutes, or an estimate
19 was derived from a nomogram for shorter duration. Cognitive testing covered four
20 domains: linguistic understanding (40 questions), spatial recognition (identifying
21 geometric shapes), general knowledge (40 questions) and ability to follow mechanical
22 instructions (problems presented as diagrams requiring knowledge of mechanics and
23 basic physics). The results of the cognitive function tests were transformed into a single
24 score with a value on a normalized standard scale ranging from 1 to 9. The conscripts
25 underwent a psychological examination to assess their potential ability to cope with
26 warfare and therefore providing an indication of their stress resilience, producing a
27 score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in
28 Swedish,¹² but it has been used in research reported in English.¹³ The medical
29 assessment produced a score of 0 to 9 to indicate the severity of any medical problems,
30 such that 9 indicated no problem, with a decreasing score indicating increasing severity
31 to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-
32 defined problem (n=22).
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Statistics Sweden provided socioeconomic and demographic data using the registers
4 they administer,¹⁴ including information on vital status and emigration from the Total
5 Population register. Childhood social and material circumstances were estimated using
6 data from the 1960 census, where the head of the household's occupation was
7 characterised as manual, agricultural, farm owners/managers, office workers, business
8 owners/managers, and others. The person per room ratio was divided into quarters of
9 its distribution. The Longitudinal database of Education, Income, and Occupation (LISA)
10 was used to obtain information on level of attained education in 1990, employment
11 status in 1985, as well employment status and receipt of disability/chronic disease
12 benefits in 1990 and 2001. Attained education - based on the duration of education
13 required for the qualification - was divided into three categories: compulsory (up to nine
14 years); up to three years post-compulsory; and over three years post-compulsory.
15 Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of
16 disability/chronic disease benefits at any time earlier in the year was recorded.
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

37 The Cause of Death Register¹⁵ provided ICD codes on causes of death, including for
38 suicide, where we also included undetermined intent as possible suicide.
39
40
41
42
43

44 **Statistical analysis**

45
46 Cox regression was used to examine the association of unemployment (compared with
47 employment) with subsequent mortality risk over two periods: unemployment in 1990
48 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who
49 received disability/chronic disease benefits at entry to either follow-up period were
50 excluded from analysis in that period. Follow-up was to death, emigration or the end of
51 the study period, whichever occurred first. The analysis was adjusted for socioeconomic
52
53
54
55
56
57
58
59
60

1
2
3 index of parents and household crowding in 1960, and the following conscription
4
5 measures: BMI in categories as in table 1, height (continuous), physical working
6
7 capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive
8
9 score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8,
10
11 and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the
12
13 later follow-up period) and region of residence. Attained age was used as the underlying
14
15 time-scale for all models to achieve the most efficient adjustment for age. The analyses
16
17 were stratified by the cognitive function score divided into equal thirds of its
18
19 distribution and then by the three-category education variable. Further analyses
20
21 excluded mortality due to suicide (including where the cause of death was recorded as
22
23 undetermined intent). Analyses then excluded the first four years of follow-up after
24
25 1990 and 2001 to allow for 'selection to wear off'.^{16 17}
26
27
28
29
30
31

32 A Cox regression model with follow-up over the entire study period (1990 to 2010)
33
34 assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for
35
36 the association with mortality for the combination of unemployment with cognitive
37
38 function or with education. Unemployment was modelled as a time-dependent covariate
39
40 and the analysis was adjusted for the potential confounding factors described above.
41
42
43
44
45

46 The statistical software used was Stata version 12/SE for Windows (StataCorp, College
47
48 Station, Texas). Tests were 2-sided and statistical significance was defined as $p < 0.05$ and
49
50 95% confidence intervals that do not include 1.00.
51
52
53
54

55 **Ethical permission**

56
57
58
59
60

1
2
3 Ethical permission to conduct this project was granted by the Uppsala Regional Ethics
4
5 Committee (Dnr 2009/306).
6
7
8

9 10 **Results**

11 All of the characteristics investigated were statistically significantly associated with
12 unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than
13
14 0.001, p values are not presented. Unemployment and receipt of a disability pension in
15
16 both periods were associated with lower parental SEI, greater household crowding, BMI
17
18 indicating underweight or obesity, diagnoses of more severe diseases at conscription,
19
20 low stress resilience, lower level qualifications, shorter stature, lower physical working
21
22 capacity, and lower cognitive function score. Higher diastolic blood pressure was
23
24 associated with unemployment and disability pension, but the pattern is more complex
25
26 for systolic blood pressure. The total number unemployed in 2001 was greater than in
27
28 1990 and the number on disability/chronic sickness benefit was notably greater in
29
30 2001. Overall, the distribution of educational attainment and cognitive function score
31
32 among the employed was very similar between the two periods, but a higher proportion
33
34 of those who experienced unemployment during the second period had lower
35
36 qualifications and cognitive function scores.
37
38
39
40
41
42
43
44
45

46 During the period 1990 to 2001, unemployment compared with employment in 1990
47
48 was associated with a statistically significantly raised risk of mortality in each of the
49
50 cognitive function and education strata, both before and after adjustment for the
51
52 potential confounding factors (table 2). Patterns of association for unemployment with
53
54 mortality are similar whether stratified by cognitive function or by education. The
55
56 results are graded by cognition and education, with the highest unemployment-related
57
58
59
60

1
2
3 mortality risk among men with the lowest cognitive function scores and education.
4
5 Exclusion of deaths due to suicide altered the gradient of risk between the first two
6
7 strata, but men with the highest cognitive function scores and qualifications remained at
8
9 lowest risk of mortality if they experienced unemployment. Some reduction in
10
11 magnitude of risk, but without loss of statistical significance, was observed when deaths
12
13 during the first four years of follow-up were excluded to allow for the 'wearing off' of
14
15 direct health selection.
16
17

18
19
20 During the period 2001 to 2010, unemployment compared with employment in 2001
21
22 was associated with a statistically significantly raised risk of mortality in each of the
23
24 education strata both before and after adjustment for the potential confounding factors
25
26 (table 3). Patterns of association for unemployment with mortality are similar whether
27
28 stratified by cognitive function or by education. In contrast with the earlier period, the
29
30 unemployment-related mortality risk, when stratified by cognition or education, is
31
32 reversed and consistently higher for the strata of those with the highest levels of
33
34 cognitive function or education. It is noteworthy that the absolute rate of
35
36 unemployment-related mortality is much more similar across the cognition and
37
38 education strata; even though there is more of a gradient among the employed. In all of
39
40 the adjusted models, after exclusion of death by suicide, and after allowing 'selection to
41
42 wear off', the gradient of unemployment-related mortality remains reversed or
43
44 eliminated compared with the earlier period: those with the higher level cognitive
45
46 function scores and qualifications had higher hazard ratios for mortality associated with
47
48 unemployment.
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 The interaction tests to assess effect modification by age/period are statistically
4 significant for both cognitive function ($p=0.004$) and education ($p=0.003$), consistent
5 with higher mortality among in men with better cognitive function or education when
6 they experience unemployment at a later age.
7
8
9
10

11 Discussion

12
13
14 Unemployment in 1990, when the men in this cohort were aged 34 to 38 years, was
15 associated with all-cause mortality: men with poorer cognitive function test scores and
16 lower-level educational attainment were at greater relative risk (measured by hazard
17 ratios) than men with higher qualifications. Unemployment in 2001 when the men were
18 aged 45 to 49 years was also associated with subsequent mortality, but the gradient was
19 reversed, such that the more intelligent and more highly qualified men were at greater
20 relative risk of mortality following unemployment. The gradient of absolute
21 unemployment-associated mortality rate, across cognition and education strata was
22 attenuated substantially by unemployment at an older age in 2001.
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38

39 Previous research using data from the USA found that low income was a greater relative
40 risk for ischaemic heart disease and depression among individuals with markers of a
41 relatively privileged childhood and higher qualifications.^{5 7} Data from older adults in
42 Britain revealed that similar economic adversity eliminated the lower depression risk
43 associated with markers of earlier advantage.⁶ We hypothesised that this *unexpected*
44 adversity results in a form of disappointment, thus increasing the risk of disease through
45 behavioural change and the systemic consequences of stress. This study is an extension
46 of the disappointment paradox concept but using longitudinal rather than cross-
47 sectional data. Unemployment at an older age among the more highly qualified and
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 those with higher cognitive function scores may represent a stressful exposure that is
4
5 more unexpected or more difficult to cope with than unemployment experienced among
6
7 men with fewer qualifications or lower cognitive function scores, as suggested by the
8
9 higher levels of unemployment-related psychological distress observed among white-
10
11 collar workers.⁸ As we are concerned with unemployment as marker of socioeconomic
12
13 adversity we did not adjust for other contemporaneous economic measures collinear
14
15 with unemployment. The earlier research used diagnoses as the outcome⁵⁻⁷ and the
16
17 results could theoretically have been influenced by more highly educated individuals
18
19 seeking health care: the use of mortality in this study is not at similar risk of bias
20
21 through health service use.
22
23
24
25
26
27

28 It has long been observed that suicide rates increase both during periods of economic
29
30 recession and also during phases of rapid economic growth; arguing that weakened
31
32 social norms, rather than poverty alone, reduces social cohesion and thus increases
33
34 suicide risk.¹⁸ A sense of coherence is relevant to an individual's adaptive capacity for
35
36 social stress¹⁹ and unemployment may be damaging in this respect. Those with higher
37
38 cognitive function and qualifications, signalling more advantages in earlier life, may be
39
40 less well adapted to coping with unemployment-related stress.^{6 7} This theoretical
41
42 framework not only potentially explains associations with suicide (the risk of which can
43
44 vary by age²⁰), as our results are similar after exclusion of suicide. Poorer adaptation to
45
46 social adversity has also been linked to increased risk of stroke,²¹ indicating effects on
47
48 the cardiovascular and possibly other systems.
49
50
51
52
53
54

55 Interaction analysis confirmed that the pattern of risk changed between the periods
56
57 such that the greater risk of mortality among men with better cognition and
58
59
60

1
2
3 qualifications who experienced unemployment at an older age was disproportionately
4 higher (a multiplicative effect). Older people who have less possibility to return to work
5 may find the consequence of the associated economic adversity more challenging,⁹
6 particularly during a period of economic contraction, despite the resources signalled by
7 higher cognition and qualifications. This unemployment-associated risk of ill health may
8 continue to increase with age.
9
10
11
12
13
14
15
16
17
18

19 Health selection can help to explain associations between unemployment and disease.²²
20 Direct health selection is where pre-existing illness increases the risk of unemployment.
21 We tackled this by excluding men with disability and sickness benefits at study entry
22 and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we
23 excluded events (deaths) in the initial years of follow-up after unemployment to allow
24 selection to 'wear off' when a high proportion of those with the most serious diseases
25 pre-dating unemployment are expected to die,¹⁶ as used in other studies of
26 unemployment and mortality, including a previous study of unemployment in Sweden.¹⁷
27 The earlier Swedish study presented evidence of direct health selection as there was
28 statistically significant excess mortality in the first four years following unemployment
29 but not subsequently.¹⁷ Therefore we excluded the first four years of the follow-up in a
30 sub-analysis. Even though the men who experienced unemployment in the second
31 period of our study may have been more selected in terms of health, our procedures to
32 tackle direct selection make this unlikely as an explanation for the reversal of the
33 unemployment-mortality gradient by cognition or education.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54

55 Indirect health selection is where personal characteristics linked with raised
56 unemployment risk are also risks for poor health.^{22 23} We adjusted for a variety of
57
58
59
60

1
2
3 measures relevant to future health and mortality risk, including chronic illnesses,
4 height,²⁴ blood pressure,¹⁰ BMI,^{25 26} cognition,^{2 3} markers of physical fitness²⁶ and stress
5
6
7 resilience. Men with the most severe disabilities or chronic illness preventing military
8
9
10 service would not have undergone some of the tests at conscription and are thus not
11
12 included in the analysis. Indirect health selection is unlikely to explain the
13
14 disappearance at a later age of the relatively protective association with higher
15
16 qualifications and cognition, as the opposite effect might be expected.
17
18

19
20
21 It should be emphasised that unemployment remained less common among the more
22
23 highly educated men and those with higher cognitive function. This means that support
24
25 and benefits will remain a bigger issue for the less highly qualified and more
26
27 disadvantaged. Unemployment can result in persistent disadvantage, including through
28
29 subsequent unstable employment,²⁷⁻²⁹ so when experienced at an earlier age it can
30
31 cause harm across an entire adult life. While it remains possible that earlier exit from
32
33 the labour market helps to explain these results, it does not alter the fact that
34
35 unemployment among older men is relatively more damaging across the social
36
37 spectrum, suggesting this is a 'critical period' where interventions might be focused.³⁰
38
39
40
41
42

43
44 The experience of unemployment can contribute to the risk of ill-health through several
45
46 mechanisms.¹ Behavioural change following unemployment, such as increases in
47
48 smoking (or failure to give up) and an unhealthy diet²⁷ can increase the risk of
49
50 cardiovascular disease and cancer. The financial disadvantage associated with
51
52 unemployment can persist even after finding a new job²⁷ and the association of poverty
53
54 with mortality is well known.³¹ Depression and stress resulting from unemployment is
55
56 also likely to be relevant, as this has may raise mortality risk through behavioural and
57
58
59
60

1
2
3 possibly systemic mechanisms.³² Stressful events and circumstances have been linked
4
5 to an increase in mortality due to suicide and cardiovascular disease.³³ The mechanisms
6
7 linking cognitive function and education with mortality may not be identical,² but the
8
9 pattern of unemployment-related mortality risk is similar when stratified by cognition
10
11 or education.
12

13 14 15 16 17 **Limitations**

18
19 Potential limitations of the study include its inclusion of only men, as women can also be
20
21 affected adversely by unemployment. This was necessary as the detailed baseline data
22
23 on health and function were collected during military conscription, which at the time
24
25 was only available to men. Disentangling age and period effects in a single cohort can be
26
27 problematic. The two time points differed in unemployment rate: the proportion
28
29 unemployed was larger in the second period, thus possibly altering selection effects. To
30
31 tackle possible selection bias we adjusted for multiple markers of susceptibility. We also
32
33 excluded events during the first part of the follow-up period to allow direct health
34
35 selection to 'wear off'. The study focused on unemployment only at two time points and
36
37 these represent times when Sweden was entering periods of economic contraction:
38
39 these were chosen when the study was designed and information on unemployment at
40
41 other times was not included in our dataset. These measures will underestimate the
42
43 experience of unemployment and does not take duration of unemployment into account.
44
45 This is likely to make our estimates less precise rather than creating spurious results.
46
47 There is a greater possibility of prior unemployment in the later period and thus greater
48
49 unemployment duration, but our adjustment for previous unemployment did not
50
51 indicate that this was driving the results. The focus of the study was on mortality as an
52
53 objective endpoint. While this will underestimate the damage to health associated with
54
55
56
57
58
59
60

1
2
3 unemployment substantially, it makes it more feasible to tackle the effects of direct
4 health selection, as less serious health events that could influence unemployment risk
5 will not contribute so notably to mortality in the first years following unemployment
6 that we excluded from the 'selection wearing off' analysis. Mortality is more likely to
7 occur at older ages and causes of mortality vary by age.
8
9

10
11
12
13
14
15
16 Unemployment during periods of economic contraction is associated with raised
17 mortality that may not be explained fully by direct or indirect health selection into
18 unemployment. With increasing age, the experience of unemployment may be
19 unexpectedly harmful to those with better cognition, higher qualifications and
20 associated resources. This highlights the importance of supporting the entire population
21 who experience unemployment during a recession and the greater vulnerability of older
22 workers.
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

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

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 Blane⁶

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 Institutet, 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~~Huset
Örebro University Hospital
701 85 Örebro
Sweden
Telephone +46 19 602 6210
scott.montgomery@orebroll.se

Word count: ~~29642~~ (abstract); ~~3432711~~ (text)

1
2
3
4
5
6
7 **Acknowledgements:** This study received support from Economic and Social Research
8 Council grant RES – 596-28-0001 to the International Centre for Life Course Studies; and
9 Strategic funding from Örebro University. Thanks are due to Oula Hussein who helped to
10 prepare the tables.
11
12

13
14
15
16 The study sponsors (ESRC and Örebro University) had no role in study design; in the
17 collection, analysis, and interpretation of data; in the writing of the report; or in the
18 decision to submit the article for publication.
19
20

21
22
23
24 SM, AM, WO and DB developed the hypotheses and designed the study. RU and AM
25 prepared the data and conducted the analysis. AM, RU, WO and P-OS identified and
26 clarified codes and measures required for the analysis. SM drafted the manuscript and
27 all contributors were involved in critical editing. SM will act as guarantor.
28
29
30

31
32
33
34 All authors have completed the Unified Competing Interest form at
35 www.icmje.org/coi_disclosure.pdf. SM received research grants from ESRC and Örebro
36 University to support this work. None of the authors, their spouses, partners, or children
37 have financial or non-financial relationships that may be relevant to the submitted work.
38
39
40

41
42
43 Data sharing: no additional data available, as the ethical permission does not allow for
44 provision of data to individuals not in the research group.
45
46
47

ABSTRACT**Objective**

To investigate if unemployment ~~during an economic downturn reduces health potentialis~~ 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 mMen 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.

1
2
3
4
5
6
7
8
9 Better cognitive function and educational attainment confer protection against
10 unemployment and facilitate a more rapid transition back to employment from
11 unemployment, thus reducing the duration of exposure to unemployment-associated
12 adversity. Therefore, health following experience of unemployment should be better
13 among those with better cognitive function and the more highly qualified. However, in
14 earlier studies we demonstrated that *unexpected* financial adversity is
15 disproportionately damaging to health,⁵⁻⁷ where adult economic disadvantage was
16 experienced among those with pre-existing markers of better health and economic
17 potential signalled by markers of childhood advantage. The disappointment paradox⁷
18 hypothesises that when individuals with greater potential and expectations encounter
19 economic adversity in adulthood the experience is relatively unexpected, resulting in
20 higher levels of stress and depression and thus also damage to other aspects of health.
21
22
23
24
25
26
27
28
29
30
31

32 This is consistent with the finding that psychological distress associated with
33 unemployment was reported more frequently reported among white-collar than blue-
34 collar workers.⁸
35
36
37
38
39

40 Unexpected economic adversity even among those with greater personal resources may
41 be a particularly damaging at *older* ages,⁹ and obtaining another job at an equivalent
42 level more difficult. As the mechanisms linking cognitive function and education with
43 mortality may not be identical,² we examined these measures separately. This study
44 uses Swedish register data to examine associations of unemployment with mortality
45 among a cohort of men born between 1952 and 1956, to test the hypothesis that
46 unemployment disproportionately eliminates health potential associated with better
47 cognitive function and higher qualifications and that the effect varies by age.
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7 Unemployment was assessed in 1990 and 2001, when the men were aged 34 to 38 and
8 45 to 49 years, respectively. In 1990 Sweden was entering a period of deep economic
9 recession and another period of significant economic contraction was beginning in 2001.
10
11

12 13 14 **Methods**

15 16 **Study population**

17
18 The cohort comprised all men born between 1st January 1952 and 31st December 1956
19 that were included in the Swedish Military Conscription Register.^{10 11} At this time the
20 majority of male Swedish citizens participated in the assessment for compulsory
21 military service that took place in late adolescence and fewer than 4% of men were not
22 involved due to chronic illness or disability. The assessments were between 1970 and
23 1975 and the majority at ages 18 and 19 years, with a small number after this time at
24 later ages. A total of 284,198 men were identified and 2,564 were excluded due to data
25 inconsistencies such as errors in the personal identification number, female sex or
26 uncertain vital status. We then excluded 225 men from the analysis with improbable
27 measures at the conscription assessment: height less than 144 cm (n=39); BMI below 15
28 (n=134), weight above 178 kg (n= 9); systolic blood pressure below 50 or above 230
29 mm Hg (n=33); and diastolic blood pressure below 30 or above 135 mm Hg (n=12). This
30 resulted in a sample of 272,768 men with data at the start of follow-up in December
31 1990. We then excluded 35,161 men with missing data for: census (18,178); education
32 (2,440); or the conscription assessments (28,483) that may have resulted from loss of
33 records. The sample available for the main analysis comprised 234,782 men.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

50 51 52 **Measures**

1
2
3
4
5
6
7 The conscription examination in late adolescence provided the following measures.
8
9 Height and weight were used to calculate BMI categories (table 1). Systolic and Diastolic
10
11 blood pressure were measured after rest in recumbent men using a
12
13 sphygmomanometer. Physical working capacity was assessed using an electronically
14
15 braked ergometer for the maximum load sustained for six minutes, or an estimate
16
17 was derived from a nomogram for shorter duration. Cognitive testing covered four
18
19 domains: linguistic understanding (40 questions), spatial recognition (identifying
20
21 geometric shapes), general knowledge (40 questions) and ability to follow mechanical
22
23 instructions (problems presented as diagrams requiring knowledge of mechanics and
24
25 basic physics). The results of the cognitive function tests were transformed into a single
26
27 score with a value on a normalized standard scale ranging from 1 to 9. The conscripts
28
29 underwent a psychological examination to assess their potential ability to cope with
30
31 warfare and therefore providing an indication of their stress resilience, producing a
32
33 score 1 to 9, which we grouped as 1-3, 4-6 and 7-9. Details of the test are available in
34
35 Swedish,¹² but it has been used in research reported in English.¹³ The medical
36
37 assessment produced a score of 0 to 9 to indicate the severity of any medical problems,
38
39 such that 9 indicated no problem, with a decreasing score indicating increasing severity
40
41 to 0, indicating a very significant problem, while a score of 1 indicated a potential but ill-
42
43 defined problem (n=22).

44
45
46 Statistics Sweden provided socioeconomic and demographic data using the registers
47
48 they administer,¹⁴ including information on vital status and emigration from the Total
49
50 Population register. Childhood social and material circumstances were estimated using
51
52 data from the 1960 census, where the head of the household's occupation was
53
54 characterised as manual, agricultural, farm owners/managers, office workers, business
55
56

1
2
3
4
5
6
7 owners/managers, and others. The person per room ratio was divided into quarters of
8 its distribution. The Longitudinal database of Education, Income, and Occupation (LISA)
9 was used to obtain information on level of attained education in 1990, employment
10 status in 1985, as well employment status and receipt of disability/chronic disease
11 benefits in 1990 and 2001. Attained education – based on the duration of education
12 required for the qualification - was divided into three categories: compulsory (up to nine
13 years); up to three years post-compulsory; and over three years post-compulsory.
14
15 Unemployment was recorded on a single day in November in 1990 and 2001. Receipt of
16 disability/chronic disease benefits at any time earlier in the year was recorded.
17
18
19
20
21
22
23
24

25
26 The Cause of Death Register¹⁵ provided ICD codes on causes of death, including for
27 suicide, where we also included undetermined intent as possible suicide.
28
29
30
31

32 **Statistical analysis**

33
34 Cox regression was used to examine the association of unemployment (compared with
35 employment) with subsequent mortality risk over two periods: unemployment in 1990
36 with follow-up to 2001; and unemployment in 2001 with follow-up to 2010. Men who
37 received disability/chronic disease benefits at entry to either follow-up period were
38 excluded from analysis in that period. Follow-up was to death, emigration or the end of
39 the study period, whichever occurred first. The analysis was adjusted for socioeconomic
40 index of parents and household crowding in 1960, and the following conscription
41 measures: BMI in categories as in table 1, height (continuous), physical working
42 capacity (continuous), systolic and diastolic blood pressure in fifths, summary cognitive
43 score (continuous), education, disease severity score (categorised as 0, 1, 2-3, 4-5, 6-8,
44 and 9). The analysis was also adjusted for employment status in 1985 (and 1990 for the
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7 later follow-up period) and region of residence. Attained age was used as the underlying
8 time-scale for all models to achieve the most efficient adjustment for age. The analyses
9 were stratified by the cognitive function score divided into equal thirds of its
10 distribution and then by the three-category education variable. Further analyses
11 excluded mortality due to suicide (including where the cause of death was recorded as
12 undetermined intent). Analyses then excluded the first four years of follow-up after
13 1990 and 2001 to allow for 'selection to wear off'.^{16 17}
14
15
16
17
18
19

20
21
22 A Cox regression model with follow-up over the entire study period (1990 to 2010)
23 assessed whether period (age) of unemployment (1990 or 2001) is an effect modifier for
24 the association with mortality for the combination of unemployment with cognitive
25 function or with education. Unemployment was modelled as a time-dependent covariate
26 and the analysis was adjusted for the potential confounding factors described above.
27
28
29
30
31
32

33
34 The statistical software used was Stata version 12/SE for Windows (StataCorp, College
35 Station, Texas). Tests were 2-sided and statistical significance was defined as $p < 0.05$ and
36 95% confidence intervals that do not include 1.00.
37
38
39
40

41 42 **Ethical permission**

43
44 Ethical permission to conduct this project was granted by the Uppsala Regional Ethics
45 Committee (Dnr 2009/306).
46
47

48 49 **Results**

50
51 All of the characteristics investigated were statistically significantly associated with
52 unemployment in 1990 and 2001 (table 1) and as they all produced p values of less than
53
54
55

1
2
3
4
5
6
7 0.001, p values are not presented. Unemployment and receipt of a disability pension in
8
9 both periods were associated with lower parental SEI, greater household crowding, BMI
10 indicating underweight or obesity, diagnoses of more severe diseases at conscription,
11
12 low stress resilience, lower level qualifications, shorter stature, lower physical working
13
14 capacity, and lower cognitive function score. Higher diastolic blood pressure was
15
16 associated with unemployment and disability pension, but the pattern is more complex
17
18 for systolic blood pressure. The total number unemployed in 2001 was greater than in
19
20 1990 and the number on disability/chronic sickness benefit was notably greater in
21
22 2001. Overall, the distribution of educational attainment and cognitive function score
23
24 among the employed was very similar between the two periods, but a higher proportion
25
26 of those who experienced unemployment during the second period had lower
27
28 qualifications and cognitive function scores.
29

30
31
32 During the period 1990 to 2001, unemployment compared with employment in 1990
33
34 was associated with a statistically significantly raised risk of mortality in each of the
35
36 cognitive function and education strata, both before and after adjustment for the
37
38 potential confounding factors (table 2). Patterns of association for unemployment with
39
40 mortality are similar whether stratified by cognitive function or by education. The
41
42 results are graded by cognition and education, with the highest unemployment-related
43
44 mortality risk among men with the lowest cognitive function scores and education.
45
46 Exclusion of deaths due to suicide altered the gradient of risk between the first two
47
48 strata, but men with the highest cognitive function scores and qualifications remained at
49
50 lowest risk of mortality if they experienced unemployment. Some reduction in
51
52 magnitude of risk, but without loss of statistical significance, was observed when deaths
53
54
55
56
57
58
59
60

1
2
3
4
5
6 during the first four years of follow-up were excluded to allow for the 'wearing off' of
7 direct health selection.
8
9

10
11
12 During the period 2001 to 2010, unemployment compared with employment in 2001
13 was associated with a statistically significantly raised risk of mortality in each of the
14 education strata both before and after adjustment for the potential confounding factors
15 (table 3). Patterns of association for unemployment with mortality are similar whether
16 stratified by cognitive function or by education. In contrast with the earlier period, the
17 unemployment-related mortality risk, when stratified by cognition or education, is
18 reversed and consistently higher for the strata of those with the highest levels of
19 cognitive function or education. It is noteworthy that the absolute rate of
20 unemployment-related mortality is much more similar across the cognition and
21 education strata; even though there is more of a gradient among the employed. In all of
22 the adjusted models, after exclusion of death by suicide, and after allowing 'selection to
23 wear off', the gradient of unemployment-related mortality remains reversed or
24 eliminated compared with the earlier period: those with the higher level cognitive
25 function scores and qualifications had higher hazard ratios for mortality associated with
26 unemployment.
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43

44 The interaction tests to assess effect modification by age/period are statistically
45 significant for both cognitive function ($p=0.004$) and education ($p=0.003$), consistent
46 with higher mortality among in men with better cognitive function or education when
47 they experience unemployment at a later age.
48
49
50
51
52

53 Discussion

54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3
4
5
6
7 measures collinear with unemployment. The earlier research used diagnoses as the
8
9 outcome⁵⁻⁷ and the results could theoretically have been influenced by more highly
10
11 educated individuals seeking health care: the use of mortality in this study is not at
12
13 similar risk of bias through health service use.

14
15
16 It has long been observed that suicide rates increase both during periods of economic
17
18 recession and also during phases of rapid economic growth; arguing that weakened
19
20 social norms, rather than poverty alone, reduces social cohesion and thus increases
21
22 suicide risk.¹⁸ A sense of coherence is relevant to an individual's adaptive capacity for
23
24 social stress¹⁹ and unemployment may be damaging in this respect. Those with higher
25
26 cognitive function and qualifications, signalling more advantages in earlier life, may be
27
28 less well adapted to coping with unemployment-related stress.^{6 7} This theoretical
29
30 framework not only potentially explains associations with suicide (the risk of which can
31
32 vary by age²⁰), as our results are similar after exclusion of suicide. Poorer adaptation to
33
34 social adversity has also been linked to increased risk of stroke,²¹ indicating effects on
35
36 the cardiovascular and possibly other systems.

37
38
39 Interaction analysis confirmed that the pattern of risk changed between the periods
40
41 such that the greater risk of mortality among men with better cognition and
42
43 qualifications who experienced unemployment at an older age was disproportionately
44
45 higher (a multiplicative effect). Older people who have less possibility to return to work
46
47 may find the consequence of the associated economic adversity more challenging,⁹
48
49 particularly during a period of economic contraction, despite the resources signalled by
50
51 higher cognition and qualifications. This unemployment-associated risk of ill health may
52
53 continue to increase with age.
54

1
2
3
4
5
6
7
8
9 Health selection can help to explain associations between unemployment and disease.²²

10 Direct health selection is where pre-existing illness increases the risk of unemployment.

11 We tackled this by excluding men with disability and sickness benefits at study entry

12 and adjusting for chronic medical conditions diagnosed in adolescence. Additionally, we

13 excluded events (deaths) in the initial years of follow-up after unemployment to allow

14 selection to 'wear off' when a high proportion of those with the most serious diseases

15 pre-dating unemployment are expected to die,¹⁶ as used in other studies of

16 unemployment and mortality, including a previous study of unemployment in Sweden.¹⁷

17 The earlier Swedish study presented evidence of direct health selection as there was

18 statistically significant excess mortality in the first four years following unemployment

19 but not subsequently.¹⁷ Therefore we excluded the first four years of the follow-up in a

20 sub-analysis. Even though the men who experienced unemployment in the second

21 period of our study may have been more selected in terms of health, our procedures to

22 tackle direct selection make this unlikely as an explanation for the reversal of the

23 unemployment-mortality gradient by cognition or education.

24
25 Indirect health selection is where personal characteristics linked with raised

26 unemployment risk are also risks for poor health.^{22 23} We adjusted for a variety of

27 measures relevant to future health and mortality risk, including chronic illnesses,

28 height,²⁴ blood pressure,¹⁰ BMI,^{25 26} cognition,^{2 3} markers of physical fitness²⁶ and stress

29 resilience. Men with the most severe disabilities or chronic illness preventing military

30 service would not have undergone some of the tests at conscription and are thus not

31 included in the analysis. Indirect health selection is unlikely to explain the

1
2
3
4
5
6
7 disappearance at a later age of the relatively protective association with higher
8 qualifications and cognition, as the opposite effect might be expected.
9

10
11
12 It should be emphasised that unemployment remained less common among the more
13 highly educated men and those with higher cognitive function. This means that support
14 and benefits will remain a bigger issue for the less highly qualified and more
15 disadvantaged. Unemployment can result in persistent disadvantage, including through
16 subsequent unstable employment,²⁷⁻²⁹ so when experienced at an earlier age it can
17 cause harm across an entire adult life. While it remains possible that earlier exit from
18 the labour market helps to explain these results, it does not alter the fact that
19 unemployment among older men is relatively more damaging across the social
20 spectrum, suggesting this is a 'critical period' where interventions might be focused.³⁰
21
22
23
24
25
26
27
28
29
30

31
32 The experience of unemployment can contribute to the risk of ill-health through several
33 mechanisms.¹ Behavioural change following unemployment, such as increases in
34 smoking (or failure to give up) and an unhealthy diet²⁷ can increase the risk of
35 cardiovascular disease and cancer. The financial disadvantage associated with
36 unemployment can persist even after finding a new job²⁷ and the association of poverty
37 with mortality is well known.³¹ Depression and stress resulting from unemployment is
38 also likely to be relevant, as this has may raise mortality risk through behavioural and
39 possibly systemic mechanisms.³² Stressful events and circumstances have been linked
40 to an increase in mortality due to suicide and cardiovascular disease.³³ The mechanisms
41 linking cognitive function and education with mortality may not be identical,² but the
42 pattern of unemployment-related mortality risk is similar when stratified by cognition
43 or education.
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

1
2
3
4
5
6
7
8
9 Unemployment during periods of economic contraction is associated with raised
10 mortality that may not be explained fully by direct or indirect health selection into
11 unemployment. With increasing age, the experience of unemployment may be
12 unexpectedly harmful to those with better cognition, higher qualifications and
13 associated resources. This highlights the importance of supporting the entire population
14 who experience unemployment during a recession and the greater vulnerability of older
15 workers, ~~irrespective of their health potential indicated by markers of protection such as~~
16 ~~cognitive function and education.~~
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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~~ health ~~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~~.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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. ~~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.

- 1
2
3
4
5
6
7 33. Fang F, Fall K, Mittleman MA, Soren P, Ye W, Adami HO, et al. Suicide and
8 cardiovascular death after a cancer diagnosis. *The New England journal of*
9 *medicine* 2012;366(14):1310-8.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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)
Illight*	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

1			
2			
3			
4	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding
5			
6			(b) Describe any methods used to examine subgroups and interactions
7			
8			(c) Explain how missing data were addressed
9			
10			(d) If applicable, explain how loss to follow-up was addressed
11			
12			(e) Describe any sensitivity analyses
13			
14	Results		
15			
16	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
17			
18			(b) Give reasons for non-participation at each stage
19			
20			(c) Consider use of a flow diagram
21			
22	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
23			
24			(b) Indicate number of participants with missing data for each variable of interest
25			
26			(c) Summarise follow-up time (eg, average and total amount)
27			
28	Outcome data	15*	Report numbers of outcome events or summary measures over time
29			
30	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
31			
32			(b) Report category boundaries when continuous variables were categorized
33			
34			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
35			
36	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			

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.