BJPsych | The British Journal of Psychiatry (2019)
Page 1 of 7. doi: 10.1192/bjp.2019.243

Paper

Late-adolescent risk factors for suicide and self-harm in middle-aged men: explorative prospective population-based study

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Background

Recent reports show alarmingly high rates of suicide in middle-aged men, yet there are few long-term prospective studies that focus on suicidal behaviour in men in this age group.

Aims

To prospectively explore associations of potential risk factors at age 18 with suicide and self-harm in middle-aged men.

Method

A population-based Swedish longitudinal cohort study of male conscripts with no history of self-harm at enlistment in 1968–1989 ($n = 987\,583$). Conscription examinations included measures of cognitive performance, stress resilience, psychiatric diagnoses, body mass index (BMI), cardiovascular fitness and muscle strength. Suicides and self-harm at age 45–65 years were identified in the National Hospital Register and Swedish Cause of Death Register. Risks were calculated using Cox proportional hazards models.

Results

Low stress resilience (cause-specific hazard ratio CHR = 2.31, 95% CI 1.95–2.74), low cognitive ability (CHR = 2.01, 95% CI 1.71–2.37) as well as psychiatric disorders and low cardiovascular fitness in late adolescence were associated with increased risk for suicide in middle-aged men. Similar risk estimates were obtained for self-harm. In addition, high and low BMI as well as low muscle strength were associated with increased risk of self-harm. Associations also remained significant after exclusion of men with self-harm before age 45.

Conclusions

This prospective study provides life-course perspective support that psychological and physical characteristics in late adolescence may have long-lasting consequences for suicidal behaviour in middle-aged men, a very large population at heightened risk of suicide.

Declaration of interest

None.

Keywords

Suicide; epidemiology; risk assessment; cohort; self-harm.

Suicide rates among middle-aged men are on the rise in some countries[1,2] and research on distal risk factors may help develop strategies for suicide prevention in this age group.[3] In 2017, death registration data for the UK showed that the highest age-specific suicide rate was found among males aged 45–49 years (24.8 per 100 000).[1] In the USA, suicide rates have been rising over the past 15 years in men in general, and in middle-aged men in particular. Between 1999 and 2014, the US suicide rate in men aged 45–64 increased by 43% (from 20.8 per 100 000 to 29.7 per 100 000).[2] Official statistics from Sweden show that the suicide rate for men in this age group (20.4 per 100 000 in 2017) is on a par with that for older men (65 years old and above) and the number of suicides is greater in 45- to 64-year-olds than in any other age group.[4] In light of the serious nature of this public health problem, it is surprising that suicidal behaviour in middle-aged men has received relatively little research attention.

Case–control studies and cross-sectional data based on interviews show that suicide in middle-aged men is associated with psychiatric disorders, previous suicide attempt, work and financial problems, relationship conflicts and legal issues.[5] This age group is less likely to experience somatic illness and health-related life events than the older adults.[5] Although the above-cited studies recognise important factors operating in close proximity to suicide, a life-course perspective is also important when planning interventions and evaluating suicide risk in clinical settings since distal factors may play a role in susceptibility to suicide later in life.[3,6–9]

A study of the 1958 British birth cohort with a follow-up time of 8–49 years reported both prenatal and early childhood risk factors for suicide.[10] However, the number of male suicides was limited ($n = 44$, including deaths of undetermined intent) and the study did not focus on suicide in middle age. There are few prospective data-sets large enough to yield adequately sized samples of individuals who died by suicide to investigate associations with potential risk factors, and the most useful data-sets for this purpose are national longitudinal data-sets linked to national death records.

Further research is clearly needed to explore the associations of distal factors with suicidal behaviour among middle-aged men. To address this need, the current study used a large national cohort of 18-year-old men who enlisted for military service. The primary aim was to prospectively explore the independent association of potential risk factors (cognitive performance, stress resilience, psychiatric diagnoses, body mass index (BMI), cardiovascular fitness and muscle strength) at age 18 with suicide and self-harm during middle age. A secondary aim was to explore the association of potential risk factors with suicidal behaviour in this age group, independently of previous self-harm.

Method

Design

We performed an exploratory, population-based prospective study of late-adolescent men who underwent compulsory military conscription examinations between 1968 and 1989. Exposure variables at age 18 (baseline) were obtained from the Swedish Military Service Conscription Register and the National Hospital Register. The follow-up period covered ages 45–64, an age group often considered to correspond to middle age.[2,4] Study outcomes (1995–2016) were identified through the Swedish Cause of Death Register (suicides)

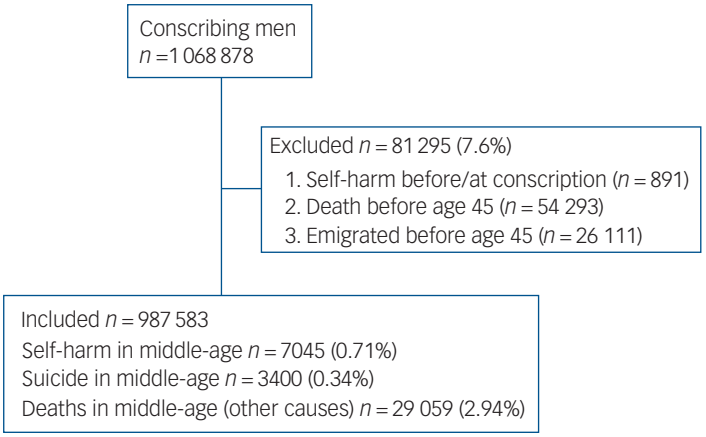

Fig. 1 Flowchart of the study populations showing included and excluded participants and number of outcomes.

and the National Hospital Register (self-harm). Covariates were obtained from the Longitudinal Integration Database for Health Insurance and Labour Market Studies. Linkage of individual register data was made possible by the unique personal identification number assigned to each registered person in Sweden. After linkage, all data were anonymised and coded by Statistics Sweden in order to maintain confidentiality. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human participants were approved by the Ethics Committee of the University of Gothenburg (462-14) and Confidentiality Clearance at Statistics Sweden. All authors have followed the International Committee of Medical Journal Editors (ICMJE) and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Study population

The source population comprised all men ($n = 1\,068\,878$) born 1950–1971 who enlisted for mandatory military service. Men aged 16–25 years at conscription were included, with a mean age of 18.2 years (s.d. = 0.7). Only individuals with severe chronic medical or mental conditions or serious disabilities and incarcerated individuals were granted exemption from military service (in all, 2–3% of the male population per year). To reduce the risk of possible reverse causation, men with reported self-harm before conscription were excluded from the analyses, as were men who died or emigrated before age 45 (Fig. 1), yielding a total of 987 583 men.

Exposure measures

At enlistment, all men underwent a 2-day examination at one of six regional conscription centres, which included assessment of physical health status and medical examination by a physician as well as a mental health assessment by a board-certified psychologist. The following exposures were obtained from the Swedish Military Service Conscription Register: cognitive performance, stress resilience, body mass index (BMI), cardiovascular fitness, muscle strength and psychiatric diagnoses. Psychiatric diagnoses were also identified through the National Hospital Register.

Cognitive performance

Subtests of four different cognitive domains were performed: verbal, visuospatial, logical-inductive and technical cognition. The cognitive performance tests are described in detail elsewhere.[6,11] Non-weighted results from the subtests were combined to create a general measure of cognitive performance. All test results were standardised against data from previous years to follow a Gaussian distribution, resulting in scores from 1 to 9. The normal-distributed standard nine (stanine) scores were then categorised as low (score 1–3), medium (score 4–6) and high (score 7–9).

Stress resilience

Stress resilience was assessed during a 25–30 min semi-structured interview performed by trained psychologists, whose interrater reliability was high ($r = 0.86$).[12] The original objective of the interview was to estimate the conscript's ability to cope with the psychological requirements of military service and war-time stress, without subsequent loss of psychological function. Stress resilience was rated and assigned a summary score between 1 and 9, following a normal distribution. More details regarding this assessment are given in the supplementary material available at https://doi.org/10.1192/bjp.2019.243.

BMI

BMI was calculated from weight and height measurements performed by the conscription physician according to a standard written protocol. BMI values <10 and >60 kg/m^2 were treated as extreme values and excluded. BMI was categorised as low (<18.5 kg/m^2), normal (18.5–24.9 kg/m^2) and high (>25.0 kg/m^2).

Cardiovascular fitness

Cardiovascular fitness was objectively measured by the conscription physician using a standardised cycle ergometer maximal test. The test started with submaximal exercise and work rate was continuously increased until exhaustion. See the supplementary material for further details regarding the procedure and validity.

Muscle strength

Trained military personnel measured isometric muscle strength using an apparatus that was calibrated daily. Overall muscle strength was obtained by integrating weighted values of knee extension (weighted 1.3×), elbow flexion (weighted 0.8×) and hand grip (weighted 1.7×) and was measured in kiloponds (until 1 April 1979) or newtons (after 1 April 1979). Test results were standardised using data from previous years and converted to a 9-point stanine scale (low to high) in order to assure long-term stability of the data-sets.

Psychiatric diagnoses

If the psychologist noted psychiatric symptoms at the interview, the conscript was further evaluated by the conscription physician, and psychiatric disorders were diagnosed according to the World Health Organization's International Classification of Diseases (ICD). For the current study, men with psychiatric disorders at conscription were also identified through the Swedish National Hospital Register, which contains both in-patient and out-patient diagnoses recorded in a hospital setting, including referrals to specialists and emergency department visits. In Sweden, it is mandatory for all private and publicly funded hospitals to register one principal discharge diagnosis and up to 30 contributory diagnoses. Register coverage for all in-patient care increased gradually between 1968 and 1986 and diagnoses from hospital out-patient care have been recorded since 2001. Depressive, neurotic, adjustment-, personality-, alcohol-related and other substance use disorders were included as baseline variables. See supplementary Table 1 for diagnostic codes as well as a reference regarding the validity of the ICD diagnoses in the Swedish National Hospital Register.

Covariates

Conscription test centre, conscription year, age at conscription and parental education were included since they are plausible covariates. Differences among regions and test centres could introduce confounding. There might also be effects of variation in diagnosis frequency and differences in conscription procedures depending on the year the participant enlisted. Socioeconomic status may affect risk of suicidal behaviour[13] as well as several of the baseline variables. We therefore adjusted the analyses for parental education. Maternal and paternal education were graded separately in three levels: education pre-high school (up to 9 years of age), high school education and university/postgraduate education. Information on parental education (80% coverage), as well as emigration, was collected from the Longitudinal Integration Database for Health Insurance and Labour Market Studies (Swedish acronym LISA) at Statistics Sweden. The LISA database is updated annually and includes data on all Swedish residents aged 16 years and above.

Outcomes

Suicides and self-harm occurring at ages 45–64 (i.e. between 1 January 1995 and 31 December 2016) were included as separate outcome variables. The following ICD codes were used for both outcomes: E950–E959 (ICD-8 and ICD-9) and X60–X84 (ICD-10); undetermined cases were not included.

Suicide death

Confirmed suicide deaths were identified through the Swedish Cause of Death Register, which is maintained at the National Board of Health and Welfare. This register covers all deaths since 1961 and is annually updated on the basis of death certificate diagnoses.

Self-harm

For the purpose of this paper, the self-harm outcome is defined as any non-fatal self-harm behaviour, regardless of the degree of suicidal intention,[14] and was obtained through ICD codes in the National Hospital Register. The Register does not distinguish between suicide attempts and self-harm without suicidal intent. The National Hospital Register identifies individuals seeking care and includes in-patients in any hospital, out-patients in specialised medical care (including psychiatric care) and emergency department visits. It does not capture episodes of self-harm by persons who seek primary care only, nor can it identify persons with no care contacts.

Statistical analysis

Cox proportional hazard models were used to estimate the cause-specific hazard ratios (CHR) and 95% CIs for suicides occurring between the ages of 45 and 64 years. The same procedure was employed for the self-harm outcome. For men with more than one self-harm episode, the first episode of self-harm that occurred between ages 45 and 64 was entered in the models. In addition to unadjusted models, age, conscription calendar year and region, and parental education were included as potential confounders in regression model 1. We also included models considering previous self-harm using two different approaches: by including self-harm prior to suicide as a time-varying covariate (model 2) and/or by subgroup analysis including only men with no self-harm prior to suicide. Model 2 was analysed differentially depending on outcome: self-harm was included as a time-dependent covariate for analyses of suicide, whereas for analyses of self-harm, self-harm before age 45 was included as a binary factor. Given that a positive correlation between stress resilience and cognitive performance has been reported,[12] we performed separate analyses of stress resilience also adjusting for cognitive performance. The follow-up period began at age 45 and person-time was included until time of outcome (suicide or self-harm), death by other causes, emigration, age 64 or end of follow-up, whichever occurred first. The category with the lowest CHR in model 1, with suicide as outcome, was used as the reference category. For predictors used in multilevel models, results both for tests of the significance of the predictor and the significance of each level are presented. Profile likelihood confidence intervals and likelihood ratio-based *P*-values from 162 hypotheses are presented, and the Benjamini–Yekutieli procedure with a false discovery rate at 0.05, i.e. a 5% risk that a significant result is a false positive, was applied to mitigate the multiple testing problem.[15] All confidence intervals were adjusted on the basis of correction of the predictor and in accordance with a false discovery rate at level 0.05. All tests were two-tailed and an adjusted *P*-value of <0.05 was considered statistically significant. All statistical calculations were performed with SAS version 9.4 for Windows (SAS Institute, NC).

Results

During follow-up, 3400 men aged 45–64 years died by suicide. At least one self-harm episode was recorded in the National Hospital Register for 7045 men. Baseline psychological and physical characteristics are shown by outcome in supplementary Table 2. Men with either outcome were more likely to have lower cognitive performance, stress resilience, BMI and cardiovascular fitness at baseline, compared with all others. They also had higher frequencies of psychiatric disorders. In general, this pattern was stronger for self-harm than for suicide.

Both low and medium levels (compared with high levels) of cognitive performance, stress resilience and cardiovascular fitness at baseline increased the risk for suicide in middle-age (Table 1). Of these factors, low stress resilience showed the highest risk (CHR = 2.31, 95% CI 1.95–2.74), followed by a low cognitive performance (CHR = 2.01, 95% CI 1.71–2.37). Adjusting for cognitive performance resulted in a minor decrease in the risk estimate for suicide associated with a low stress resilience level (CHR = 2.03, 95% CI 1.71–2.42) (supplementary Table 3). Among the psychiatric disorders, the highest CHR was observed for alcohol- and drug-related disorder (CHR = 3.25, 95% CI 2.39–4.29), followed by personality

Table 1 Cause-specific hazard ratios (CHRs) for suicides in middle-aged men (age 45–64 years) in relation to risk factors in late adolescence

Risk factors at baseline (mean age 18 years)	Suicides/total population, *n/n*	Unadjusted		Model 1		Model 2	
		CHR (95% CI)	$P_{adj.}$	CHR (95% CI)	$P_{adj.}$	CHR (95% CI)	$P_{adj.}$
General cognitive performance							
Low	943/968 882	2.08 (1.78–2.44)	<0.001	2.01 (1.71–2.37)	<0.001	1.73 (1.48–2.03)	<0.001
Medium	1788/968 882	1.51 (1.31–1.75)	<0.001	1.49 (1.29–1.72)	<0.001	1.41 (1.23–1.63)	<0.001
High (ref.)	564/968 882	1.0		1.0		1.0	<0.001
Stress resilience							
Low	715/952 281	2.41 (2.04–2.85)	<0.001	2.31 (1.95–2.74)	<0.001	1.96 (1.66–2.32)	<0.001
Medium	1279/952 281	1.36 (1.16–1.59)	<0.001	1.33 (1.14–1.56)	<0.001	1.29 (1.11–1.50)	<0.001
High (ref.)	391/952 281	1.0		1.0		1.0	<0.001
Psychiatric disorders							
Depressive/neurotic/adjustment	446/987 583	2.00 (1.72–2.32)	<0.001	1.96 (1.68–2.27)	<0.001	1.66 (1.43–1.92)	<0.001
Personality	122/987 583	2.38 (1.81–3.07)	<0.001	2.29 (1.74–2.94)	<0.001	1.88 (1.44–2.40)	<0.001
Alcohol-/drug-related	104/987 583	3.29 (2.43–4.35)	<0.001	3.25 (2.39–4.29)	<0.001	2.27 (1.69–2.98)	<0.001
BMI							
Underweight	274/965 721	1.15 (0.99–1.33)	0.067	1.15 (0.99–1.33)	0.087	1.12 (0.97–1.30)	0.24
Normal (ref.)	1905/965 721	1.0		1.0	0.28	1.0	0.63
Overweight	206/965 721	1.07 (0.91–1.26)	1.00	1.06 (0.89–1.24)	1.00	1.05 (0.89–1.23)	1.00
Cardiovascular fitness							
Low	489/832 568	1.53 (1.30–1.80)	<0.001	1.50 (1.28–1.77)	<0.001	1.40 (1.19–1.64)	<0.001
Medium	1316/832 568	1.32 (1.16–1.50)	<0.001	1.30 (1.14–1.48)	<0.001	1.26 (1.11–1.43)	<0.001
High (ref.)	580/832 568	1.0		1.0		1.0	<0.001
Muscle strength							
Low	294/645 781	1.08 (0.91–1.28)	1.00	1.05 (0.89–1.25)	1.00	1.01 (0.86–1.20)	1.00
Medium	1493/645 781	1.02 (0.91–1.15)	1.00	1.00 (0.89–1.13)	1.00	0.99 (0.88–1.12)	1.00
High (Ref.)	598/645 781	1.0		1.0		1.0	

Ref., reference category; BMI, body mass index; model 1: adjusted for age, conscription calendar year and region, and parental education; model 2: adjusted for age, conscription calendar year and region, parental education and self-harm during follow-up.

disorder and depressive/neurotic/adjustment disorder. When also adjusting for the presence of one or more self-harm events during follow-up, all risks decreased but remained significant (Table 1, model 2).

Separate analyses of the four different cognitive domains showed that low and medium levels of all domains at baseline were associated with increased risk (supplementary Table 4). Baseline performance on cognitive domains are shown by outcome in supplementary Table 5. Analyses of men with or without any self-harm between ages 18 and 45 revealed no differences in the risk of suicide (Table 2).

Similar to the results for the suicide outcome, elevated risk estimates for self-harm in middle age were observed for low or medium levels of baseline cognitive performance, stress resilience and

Table 2 Subgroup analysis of cause-specific hazard ratios (CHRs) for suicide in middle-aged (age 45–64 years) men in relation to risk factors in late adolescence. Excluding all men with self-harm before age 45.

	Suicides/total population, *n/n*	Unadjusted		Model 1	
		CHR (95% CI)	$P_{adj.}$	CHR (95% CI)	$P_{adj.}$
General cognitive performance					
Low	603/963 515	2.00 (1.71–2.35)	<0.001	1.94 (1.65–2.29)	<0.001
Medium	1267/963 515	1.47 (1.28–1.70)	<0.001	1.45 (1.26–1.68)	<0.001
High (ref.)	426/963 515	1.0		1.0	
Stress resilience					
Low	1034/947 097	2.32 (1.96–2.76)	<0.001	2.23 (1.88–2.65)	<0.001
Medium	1725/947 097	1.33 (1.14–1.56)	<0.001	1.31 (1.12–1.54)	<0.001
High (ref.)	488/947 097	1.0		1.0	
Psychiatric disorders					
Depressive/neurotic/adjustment	422/981 894	1.99 (1.70–2.32)	<0.001	1.94 (1.66–2.26)	<0.001
Personality	115/981 894	2.36 (1.78–3.05)	<0.001	2.24 (1.69–2.89)	<0.001
Alcohol-/drug-related	97/981 894	3.25 (2.38–4.33)	<0.001	3.20 (2.34–4.26)	<0.001
BMI					
Underweight	265/960 437	1.17 (1.00–1.35)	0.044	1.16 (0.99–1.34)	0.070
Normal (ref.)	1832/960 437	1.0		1.0	
Overweight	199/960 437	1.06 (0.89–1.25)	1.00	1.04 (0.87–1.23)	1.00
Cardiovascular fitness					
Low	462/828 247	1.47 (1.25–1.73)	<0.001	1.46 (1.24–1.72)	<0.001
Medium	1271/828 247	1.30 (1.14–1.49)	<0.001	1.29 (1.13–1.48)	<0.001
High (ref.)	563/828 247	1.0		1.0	
Muscle strength					
Low	279/643 375	1.07 (0.90–1.27)	1.00	1.04 (0.87–1.23)	1.00
Medium	1439/643 375	1.01 (0.90–1.14)	1.00	0.99 (0.88–1.12)	1.00
High (ref.)	578/643 375	1.0		1.0	

Ref., reference category; BMI, body mass index; model 1: adjusted for age, conscription calendar year and region, and parental education.

Table 3 Cause-specific hazard ratios (CHRs) for self-harm in middle-aged men (age 45–64) in relation to risk factors in late adolescence

		Unadjusted		Model 1	
	Self-harm/total population, *n/n*	CHR (95% CI)	$P_{adj.}$	CHR (95% CI)	$P_{adj.}$
General cognitive performance					
Low	2541/968 882	2.34 (2.20–2.48)	<0.001	2.24 (2.12–2.38)	<0.001
Medium	3376/968 882	1.44 (1.36–1.52)	<0.001	1.40 (1.33–1.48)	<0.001
High (ref.)	838/968 882	1.0		1.0	
Stress resilience					
Low	2641/952 281	2.55 (2.38–2.73)	<0.001	2.44 (2.28–2.61)	<0.001
Medium	3197/952 281	1.28 (1.20–1.37)	<0.001	1.25 (1.17–1.33)	<0.001
High (ref.)	784/952 281	1.0		1.0	
Psychiatric disorders					
Depressive/neurotic/adjustment	1201/987 583	2.03 (1.92–2.13)	<0.001	1.96 (1.87–2.07)	<0.001
Personality	304/987 583	2.40 (2.20–2.62)	<0.001	2.31 (2.12–2.52)	<0.001
Alcohol-/drug-related	333/987 583	3.89 (3.54–4.28)	<0.001	3.80 (3.45–4.17)	<0.001
BMI					
Underweight	767/965 721	1.10 (1.04–1.17)	<0.001	1.10 (1.04–1.16)	<0.001
Normal (ref.)	5301/965 721	1.0		1.0	
Overweight	643/965 721	1.61 (1.53–1.70)	<0.001	1.58 (1.50–1.66)	<0.001
Cardiovascular fitness					
Low	1394/832 568	1.73 (1.63–1.83)	<0.001	1.70 (1.60–1.80)	<0.001
Medium	3077/832 568	1.34 (1.28–1.41)	<0.001	1.32 (1.26–1.39)	<0.001
High (ref.)	1106/832 568	1.0		1.0	
Muscle strength					
Low	804/645 781	1.18 (1.12–1.25)	<0.001	1.18 (1.12–1.24)	<0.001
Medium	3493/645 781	0.99 (0.95–1.03)	0.574	0.99 (0.95–1.03)	0.463
High (ref.)	1335/645 781	1.0		1.0	

Ref., reference category; BMI, body mass index; model 1: adjusted for age, conscription calendar year and region, and parental education.

cardiovascular fitness (Table 3). In addition, low muscle strength and a high or low BMI were associated with increased risk for self-harm. Elevated hazards ratios for self-harm were observed for all psychiatric disorders, with the highest risk for alcohol- and drug-related disorder (CHR = 3.80, 95% CI 3.45–4.17). Apart from alcohol- and drug related disorder, the risks were highest for low stress resilience (CHR = 2.44, 95% CI 2.28–2.61) and low cognitive performance (CHR = 2.24, 95% CI 2.12–2.38). Adjusting analyses of stress resilience for cognitive performance gave CHR = 2.05, 95% CI 1.98–2.13 (supplementary Table 3). Results from subgroup analyses of men with incident self-harm between ages 45 and 64 were similar to those for the total group (supplementary Table 6).

Discussion

Main findings

We show that low stress resilience, low cognitive ability, psychiatric illness and low cardiovascular fitness in late adolescence were all associated with increased risk for both suicide and self-harm in middle-aged men. In addition, elevated risk estimates for self-harm were observed for high or low BMI and low muscle strength in late adolescence.

Comparison with findings from other studies

Alcohol- and drug-related disorder in late adolescence were the strongest predictor for suicide in middle-aged men. This expands on previous findings focusing on suicide early in the life-course[9] and in adults of mixed ages (23–60 years),[6] and highlights the need for suicide prevention programmes to target unhealthy drinking habits.[16]

Low stress resilience in late adolescence increased the risk for suicidal behaviour in middle age, also when adjusting for cognitive abilities. Personality traits such as neuroticism, extraversion, impulsiveness, aggression and hopelessness have been associated with suicidal behaviour previously using cross-sectional, case–control and psychological autopsy studies of mixed-aged, younger and older populations,[17] but very few studies are prospective in design and studies targeting suicides in middle-aged men are lacking for comparison.[13] A low stress resilience would increase the amount of excessive real or perceived psychosocial stress an individual is exposed to and has also been associated with an increased risk of receiving antidepressant and anxiolytic medication in men aged 50–58.[18] Hence, low stress resilience could pose an early vulnerability to effects of stressful events that may interact with more proximal adverse life events later in life, triggering suicidal behaviour in middle age, in line with the stress–diathesis model.[3,7,8,10] A low resilience to stress could also cause maladaptive responses of the hypothalamic–pituitary–adrenal (HPA) axis and induce unfavourable effects in several brain functions, and hence predispose an individual to suicidal behaviour.[19] Overall, low baseline cognitive performance was associated with suicide and self-harm in middle age, in accordance with studies employing shorter observational periods.[6,11]

Both high and low BMI at baseline were associated with an increased risk for self-harm. Although most studies report inverse associations between BMI and suicide or self-harm, there is evidence for an association between obesity and attempted suicide.[20] The reason remains unknown, but increased risk of suicidal behaviour due to unexpected weight loss has been suggested as a possible explanation.[20] However, we lack information regarding BMI after baseline to investigate possible weight loss.

Low cardiovascular fitness at baseline was associated with both suicide and self-harm in middle age and low muscle strength was associated with self-harm. Disruptions in the HPA axis, reduced brain plasticity and decreased brain-derived neurotrophic factor (BDNF) functioning have all been associated with suicidal behaviour.[19] Physical activity increases levels of BDNF, has positive effects on brain plasticity and increases the brain reserve capacity.[21] This might reduce the risk of suicidal behaviour at times of distress. We could identify no studies focusing on this age group for comparison. In our previous study of suicides in men over a broad age range,[6] we could show elevated risk for suicidal behaviour

(non-fatal and fatal combined), but this was not the case when suicide was treated as a separate outcome in that study. The disparity might be related to methodological differences, including different age groups, differential categorisation of cardiovascular fitness or use of different covariates.

Most of the observed associations of the current baseline variables were similar in strengths for both outcomes. Some researchers suggest that adult suicide attempters and completers should be considered two distinct populations that partially overlap.[22] In this respect, suicidal behaviour in middle age may differ from that in younger adults. The latter group has a higher risk of self-harm, whereas the risk of suicide increases with increasing age.[22] Risk profiles for fatal and non-fatal outcomes may overlap more in middle age than in young adulthood, paralleling findings reported for those aged 70 and above.[23]

Strengths and limitations

Strengths of this study include the prospective and population-based design and the large sample size. The study has a long follow-up and uses high-quality national registers with enough power to identify factors associated with suicide and self-harm in middle-aged men. Another strength is the reliance on psychologists and physicians for baseline assessment of suicidal history, allowing us to exclude individuals with self-harm before the conscription examination, thereby reducing the risk of reverse causation. Objective measurements of physical variables such as cardiovascular fitness at baseline provide an advantage compared with self-reported levels.

The study is exploratory and a false-positive rate at 5% implies that as much as 5% of our significant result could be due to false positives. Hence, all findings should be interpreted with caution. The exploratory nature of the study also makes it hard to conduct predictor-specific adjustments for confounders and, as always in observational studies, the possibility of confounding by unmeasured factors cannot be excluded. However, the variables adjusted for in the analyses are potential confounders (and not mediators) for all assessed associations.

A further consideration is that we lack data on adolescent suicidal ideation. As this phenomenon is associated with higher rates of mental disorders, suicidal ideation and behaviour, and poor functioning at age 30,[24] we would anticipate that it would be likely to affect the prospective associations observed in our study.

The incidence of self-harm may be underestimated owing to the use of the National Hospital Register, which lacks data from primary care and from individuals who do not seek care at all. Another methodological consideration is the fact that our study design precludes identification of non-suicidal self-harm. This would, however, present a greater limitation were we focusing on a younger age group or a cohort that also included women.

Analyses only included men who were still alive at age 45, which could create a healthy survivor effect. However, that would only underestimate the true magnitude of association with suicidal behaviour. Although men with psychiatric disorders were recorded from both the National Hospital Register and the Swedish Military Service Conscription Register, subsyndromal states that might have affected the risk of future suicidal behaviour may have been missed. Further, some may have opted not to report self-harm before conscription.

Our research aim was to investigate the associations of distal risk factors with suicidal behaviour in middle age, and not to study changes over time. Therefore, potential risk factors were measured at late adolescence only. Although major changes in cognitive performance and stress resilience would not be anticipated over time, the physical variables are more prone to change. The risk factors recorded at late adolescence may also have influenced each other owing to the cross-sectional nature of the conscription examination measures.

Results regarding the stress resilience test cannot be replicated in other settings since detailed descriptions, manuals and validation studies remain classified by the Swedish armed forces. Further, although it was mandatory by law for all men to perform the conscription tests, 2–3% of the male population did not conscribe owing to imprisonment or severe chronic somatic or mental conditions or functional disabilities, including diseases of the nervous system, intellectual disability ('mental retardation'), cerebral palsy and diseases of the musculoskeletal system.[25] This introduces a selection bias favouring individuals without severe illness. A final consideration is that the current cohort is homogeneous regarding gender and ethnicity, which may limit its generalisability for women and for middle-aged men in other populations.

Implications

Suicide in middle-aged men is a significant health concern requiring urgent attention. The current study provides new insights into long-term risk factors for suicidal behaviour in middle-aged men, emphasising the need for clinicians to take a life-course perspective when assessing potential suicide risk. The over two-fold risk associated with low stress resilience points to a need for interventions that take the individual's coping ability into consideration. The fact that most associations were similar for men with and without previous self-harm highlights the importance of also targeting individuals without a history of self-harm for clinical suicide prevention.

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First received 26 Feb 2019, final revision 10 Sep 2019, accepted 12 Oct 2019

Funding

This work was supported by the Swedish state under the ALF agreement between the Swedish government and the county councils (H.G.K., ALFGBG-726541), (M.W., ALFGBG-715841), the Swedish Research Council (H.G.K, 521-2014-3224) and the Stiftelsen Peter Erikssons minnesfond för hjärnforskning (J.N.).

Data availability

All authors have full access to the study data. Access is ongoing.

Author contributions

All authors contributed substantially to the design of the study and the data acquisition. J.N. and S.G. performed the analyses. All authors contributed to interpretation of the data as well as drafting and critically revising the manuscript for important intellectual content.

Supplementary material

Supplementary material is available online at https://doi.org/10.1192/bjp.2019.243.

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