

Cause and effect in studies on unemployment, mental health and suicide: a meta-analytic and conceptual review

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Background. There are ongoing questions about whether unemployment has causal effects on suicide as this relationship may be confounded by past experiences of mental illness. The present review quantified the effects of adjustment for mental health on the relationship between unemployment and suicide. Findings were used to develop and interpret likely causal models of unemployment, mental health and suicide.

Method. A random-effects meta-analysis was conducted on five population-based cohort studies where temporal relationships could be clearly ascertained.

Results. Results of the meta-analysis showed that unemployment was associated with a significantly higher relative risk (RR) of suicide before adjustment for prior mental health [RR 1.58, 95% confidence interval (CI) 1.33–1.83]. After controlling for mental health, the RR of suicide following unemployment was reduced by approximately 37% (RR 1.15, 95% CI 1.00–1.30). Greater exposure to unemployment was associated with higher RR of suicide, and the pooled RR was higher for males than for females.

Conclusions. Plausible interpretations of likely pathways between unemployment and suicide are complex and difficult to validate given the poor delineation of associations over time and analytic rationale for confounder adjustment evident in the revised literature. Future research would be strengthened by explicit articulation of temporal relationships and causal assumptions. This would be complemented by longitudinal study designs suitable to assess potential confounders, mediators and effect modifiers influencing the relationship between unemployment and suicide.

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Introduction

The association between unemployment and suicide has been demonstrated in numerous studies (Platt, 1984; Yoshimasu *et al.* 2008, Li *et al.* 2011; Milner *et al.* 2012). There are, however, continuing questions about the causality of this relationship because of the influence of numerous other factors that are common prior causes (confounders) of both unemployment and suicide (Lundin *et al.* 2012; Maki & Martikainen, 2012). Pre-existing mental health issues are cited as risk factors for both suicide and unemployment, as those with psychological problems have a greater tendency to leave employment and are also

at increased risk of suicide (Li & Sung, 1999; Shah, 2009).

Mental health can also be affected by unemployment. A past meta-analysis of over 140 studies indicated that mental health worsens after the loss of a job, and that mental health improves once a person is re-employed (Paul & Moser, 2009). Considering this, it is possible that mental disorders are on the causal pathway (i.e. intermediaries) between unemployment and suicide (Lewis & Sloggett, 1998; Blakely *et al.* 2003). Changes to mental health status as a consequence of job loss is consistent with theories of social causation, which suggest that changes in employment lead to poor health outcomes (Hudson, 2005).

Notwithstanding a few notable exceptions (Lewis & Sloggett, 1998; Blakely *et al.* 2003), studies of unemployment and suicide have generally assumed that illnesses (mainly mental disorders, with a few references to other illnesses or general measures such as sickness absence from work) are confounding variables that

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are common prior causes of both unemployment and suicide (Mortensen *et al.* 2000; Qin *et al.* 2000; Lundin & Hemmingsson, 2009). Researchers have attempted to adjust for this source of bias statistically by adjusting for pre-existing health status into analytical models (as confounders) (Morrell *et al.* 1999; Qin *et al.* 2000; Mortensen *et al.* 2000; Fergusson *et al.* 2001, 2007; Agerbo, 2003; Kraut & Walld, 2003, Lundin *et al.* 2010, 2012).

There have been two other major reviews on the relationship between unemployment and suicide. One of these was conducted by the authors of the present paper on the topic of unemployment duration, not explicitly considering the influence of mental health problems (Milner *et al.* 2013b). The other review assessed literature up to the 1980s and is now considerably outdated (Platt, 1984). There have been a number of other reviews in which unemployment was included as a dimension of socio-economic position, but was not the primary focus of analyses (Yoshimasu *et al.* 2008; Li *et al.* 2011; Milner *et al.* 2013a). Given the general interest in the association between unemployment and suicide, there is a need to assess the implied 'causal' associations between unemployment, mental disorder and suicide presented in empirical studies.

Past papers have highlighted the need to consider mental health conditions as possible causes, rather than outcomes of unemployment (Blakely *et al.* 2003; Lewis & Sloggett, 1998). However, there are no previous papers that give a detailed exposition of the implicit causal assumptions about the role of mental illness in analytic studies of unemployment and suicide. Drawing on data from high-quality retrospective cohort studies in a meta-analytic review, this paper will examine the temporal relationships between the development of mental health problems in relation to the loss of a job and subsequent suicide. The review also investigates influences based on sex, mental health measures, and the overall exposure to unemployment (e.g. length of time seeking a job). By investigating the temporality of the relationships between key variables in the reviewed studies, we will propose a number of possible causal pathways through the use of direct acyclical graphs (DAGs). DAGs allow researchers to explicitly examine assumptions about the direction of relationships between exposures and outcomes (Glymour, 2008). Representing these assumptions in generic causal graphs can provide clarification of what analytic strategies are appropriate for studies on unemployment and suicide, but also may be particularly helpful in studies on mental health and suicide given their complexity in determinants, modifying, and mediating factors.

Method

We chose to focus on deaths rather than attempts, as studies on suicide attempts tend to be confined to small sample areas, or clinical populations, and often are not representative of the general population. Further, most research on unemployment and suicide has been conducted in relation to deaths, rather than attempts. To be included in the meta-analysis, studies needed to provide comparable measurements of mental health in relation to exposure (unemployment) and outcome (suicide) at a population level over time. The review also sought to examine the key analytical and methodological features in studies exploring the association between unemployment, suicide and mental health.

Inclusion and exclusion criteria

Inclusion and exclusion criteria were based upon a past meta-analysis conducted by the authors (Milner *et al.* 2013b). Articles were included if search terms were in the abstract or title of the paper and were published in the last 30 years (i.e. 1980 or later), which was when one of the last review studies on unemployment and suicide was conducted (criterion A) (Platt, 1984). After a review of the title and abstract, review articles, editorials and papers not in English were excluded. Only peer-reviewed research was considered (criterion B). Duplicates were also removed. The abstract and text were reviewed to assess whether unemployment was a key independent variable (main exposure) of interest (criterion C) and suicide was a measured outcome variable (criterion D). We were particularly interested in studies able to assess a dose-response relationship between unemployment (e.g. time exposed to unemployment) and suicide. Among the remaining articles, studies that measured the temporal relationship between unemployment, mental health and suicide were included, i.e. retrospective or prospective longitudinal cohort studies (criterion E). Following this, articles that did not include suicide deaths only (excluding attempts and ideation) as an outcome variable were excluded (criterion F).

Databases and search terms

The search was conducted using four databases: PubMed, Web of Knowledge, Scopus and ProQuest. These databases were chosen to ensure that the literature search strategy comprehensively examined research from medicine, epidemiology, sociology and psychology. Terms used for the search were: suicid* OR self injur* OR deliberate self harm AND job loss OR unemploy*. A secondary search of reference lists was undertaken from within retrieved articles.

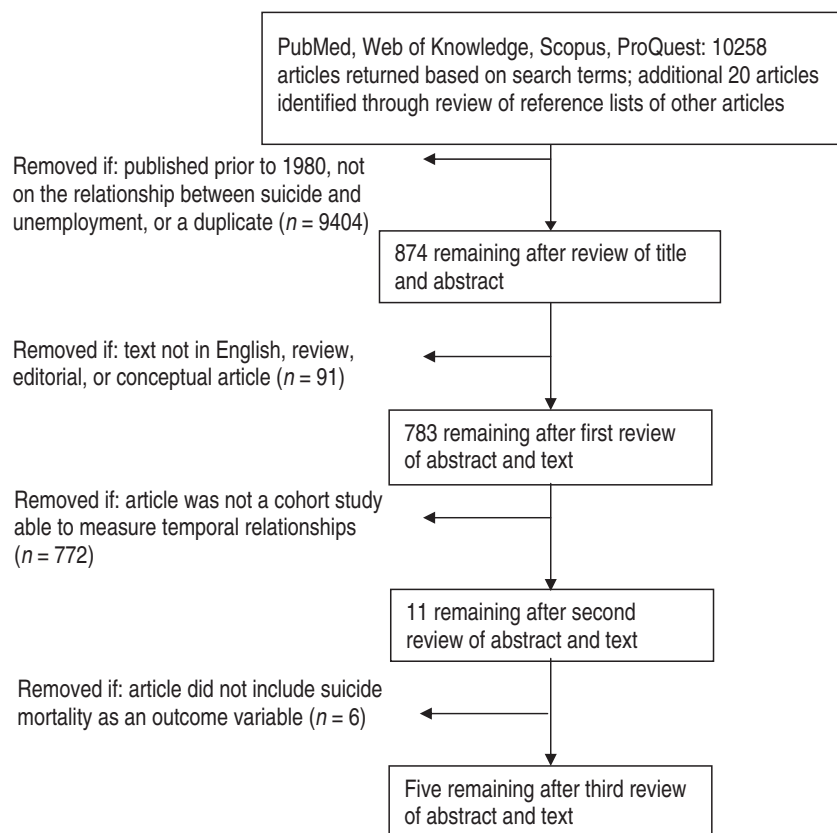


Fig. 1. Article inclusion and exclusion process.

Authors were contacted to identify additional statistical details on retrieved studies. The first author of this paper (A.M.) conducted the initial searches and shortlisting. Subsequent searches and checking were undertaken by the other two authors (A.P. and A.D.L.), with mismatches in classification resolved by consensus.

Data extraction

The data extracted from identified studies included the measures of association between unemployment and suicide before and after controlling for mental health. The results of studies were described individually using summary measures such as risk or rate ratios.

Meta-analysis

Pooled effect size and 95% confidence intervals (CIs) were calculated using a random-effects meta-analysis with the inverse variance (DerSimonian and Laird) method. The effects assessed to be eligible in the meta-analysis included hazard, odds or rate ratios. Heterogeneity between studies was assessed using the I^2 statistic, which provided an estimate of the percentage of variability in the outcome due to differences in exposure–outcome association. Adjusted and

unadjusted estimates (with 95% CIs) were used and results were stratified by sex. The meta-analysis was carried out in Stata Version 12 (StataCorp LP, USA). A meta-regression was carried out to assess the extent to which the use of different types of mental health measures influenced results. Publication bias and small study effects were assessed through inspection of funnel plots (Harbord *et al.* 2009).

Results

The process for excluding articles can be seen in Fig. 1. After reviewing titles and abstracts, articles were excluded if they did not fulfil the criteria described above. Over 9000 of the excluded studies did not explicitly measure the association between unemployment and suicide, were duplicates or were published prior to 1980. A large number of articles ($n=772$) were excluded as they did not measure the temporal relationships between the variables of interest. The final number of studies reviewed for this paper can be seen in online Supplementary Table S1. The majority of these studies were based in Denmark or Sweden from the year 2000 onwards. One study was based in Australia (Morrell *et al.* 1999). Only two

studies (Qin *et al.* 2000; Lundin *et al.* 2012) assessed male and female cases separately.

Study quality

The quality of studies was assessed before inclusion in the meta-analysis based on published recommendations (Sanderson *et al.* 2007). All studies considered used retrospective cohort designs and reported on suicide, unemployment and mental health conditions over time (online Supplementary Table S1). Mental health was assumed to be a confounder, rather than a mediator, of the relationship between unemployment and suicide in all included studies. Retrospective cohort designs capturing data at the population level were deemed to be the highest-quality studies available as these are able to assess temporal relationships between key variables (unlike cross-sectional case-control studies).

Measurement of mental health, unemployment and the characteristics of studies

Most of the studies examined the extent to which individuals were exposed to unemployment (e.g. the amount of time spent unemployed). There were some differences in the indicators used to measure mental health. The majority of studies ascertained information on psychiatric disorders from national hospital databases, which provided historical information on admissions for psychiatric disorders (Mortensen *et al.* 2000; Qin *et al.* 2000; Agerbo, 2005; Lundin *et al.* 2010). This is likely to provide information on severe cases requiring medical attention. Lundin *et al.* (2012) studied the effect of sickness absence from work (through the sickness absence compensation available to all employees earning above US\$929.10 annually). This approach would provide a more generalized understanding of possible confounding health influences, as it would include mild mental health conditions as well as more severe illnesses. Even though the study by Lundin *et al.* (2012) was not specifically related to mental disorder, we decided to retain it in the meta-analysis because sickness absence from work could be driven by either mental and physical illness and previous research by the authors (using the same dataset) found that that sickness absence is highly correlated with psychiatric disorder (Lundin *et al.* 2010). Morrell *et al.* (1999) also conducted a cohort study of unemployment and employed youth that controlled for mental health by using reported interview scores from the General Health Questionnaire. This paper was later excluded because of its small sample size (which affected the size of the CIs) and because information on mental health was self-reported rather than being drawn from objective

accounts such as hospital or sickness absence records at the national level.

Influence of unemployment on suicide after controlling for pre-existing mental disorder or sickness absence

The meta-analysis was conducted on a subset of cohort studies able to provide relatively comparable measures of unemployment, mental health conditions and suicide over time (Mortensen *et al.* 2000; Qin *et al.* 2000; Agerbo, 2005; Lundin *et al.* 2010, 2012) (online Supplementary Table S1).

In the overall analysis, the effect of unemployment was associated with a 1.41 relative risk (RR) of suicide (95% CI 1.21–1.60). The results in Fig. 2 show the subgroup estimates for the 12 observations (from five studies) in the unadjusted (without mental disorder) analyses, and the subgroup estimates for the 13 observations (also from five studies) in the adjusted analyses.

As can be seen in the random-effects subgroup meta-analyses before and after adjustment, unemployment (compared with employment) was associated with a significantly higher RR of suicide before adjustment (RR 1.58, 95% CI 1.33–1.83). After controlling for prior mental health problems, the RR of suicide following unemployment was reduced but remained statistically significant (RR 1.15, 95% CI 1.00–1.30).

Results also indicated that greater exposure to unemployment was associated with higher RR of suicide than lesser exposure to unemployment. Greater exposure to unemployment was measured as being over 90 days of unemployment (Lundin *et al.* 2010), or over 20% of time unemployed (Mortensen *et al.* 2000; Qin *et al.* 2000). Shorter duration of unemployment was measured as between 1 and 89 days (Lundin *et al.* 2010), or under 20% of time unemployed (Mortensen *et al.* 2000; Qin *et al.* 2000). This was particularly pronounced for males.

The overall pooled RR was 1.51 (95% CI 1.19–1.83) for males and 1.15 (95% CI 0.85–1.45) for females. Results also differed depending on the health variables controlled for in analyses. For example, Lundin *et al.* (2010) assessed the relationship between unemployment and suicide after controlling for psychiatric disorders noted at an army conscription interview in 1969, or psychiatric diagnosis given at time of hospitalization between 1973 and 1991. The respective odds ratios were 2.11 (95% CI 1.26–3.52) and 1.77 (95% CI 1.05–2.98). It is likely that the higher odds ratio for conscription interview is because data were obtained through self-report methods and may be more sensitive to detecting mild conditions, while hospitalization

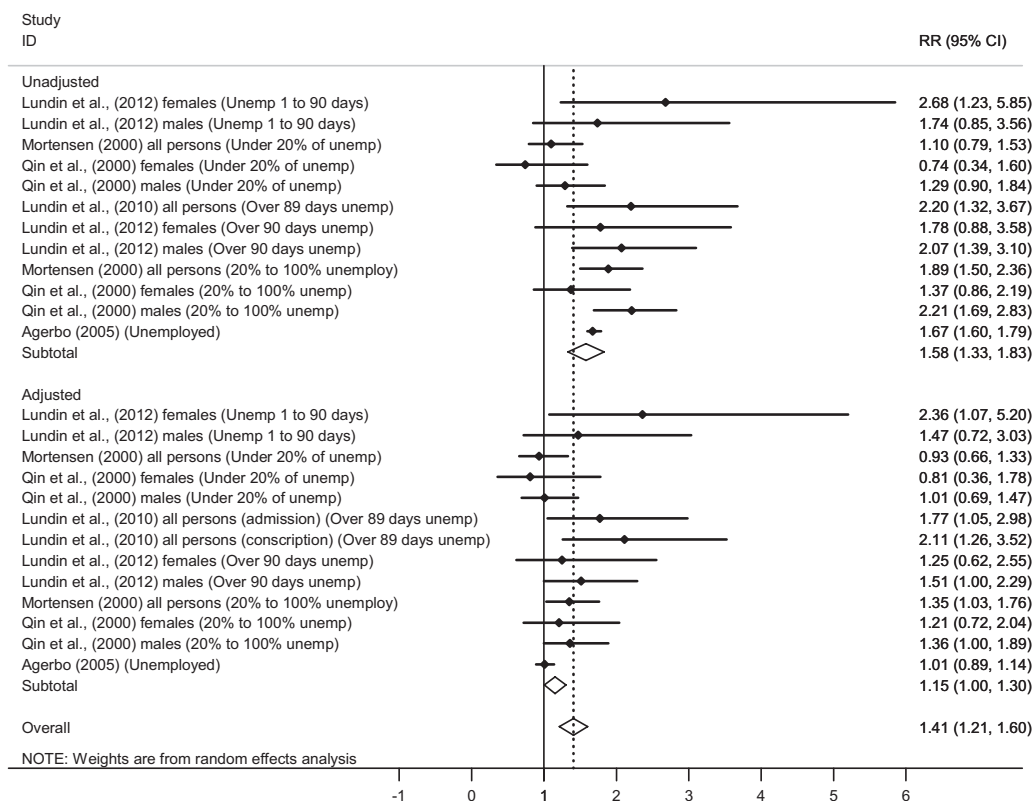


Fig. 2. Forest plot of suicide risk following unemployment (unemp), before and after adjusting for mental disorder; results of meta-analysis. Reference is the employed population. RR, Relative risk; CI, confidence interval.

is likely to reflect more severe conditions requiring medical attention. Also, the interviews covered up to 98% of the population, while only a small proportion (3% of those who were employed and between 5.1% and 7.7% of those who were unemployed) of suicide cases had been admitted for a psychiatric disorder.

Sensitivity analyses

Meta-regression revealed no significant differences between the types of mental health variables (admission for psychiatric disorders, psychiatric disorders given at an army conscription interview, sickness absence, hospitalization for psychiatric disorders, drug abuse) used to adjust for mental disorders ($p=0.7212$). Assessment of publication bias and small-study effects indicated that the majority of studies fell within the pseudo 95% CIs (online Supplementary Fig. S1). Small-study effects were apparent in the Eggers *et al.* (1997) test (Harbord *et al.* 2009). The estimated coefficient was 0.93 (s.e.=0.43, $p=0.045$). The most obvious source of bias may be the disparate results seen in Lundin *et al.* (2012). This result could also be influenced by the small number of studies included in the meta-analysis. A further sensitivity test was undertaken to assess the effects of excluding

Lundin *et al.* (2012) from the study. The overall pooled RR of unemployment on suicide dropped to 1.40 (95% CI 1.13–1.57) after this study was excluded. The RR remained significant before mental health variables were considered (RR 1.52, 95% CI 1.23–1.81), but reduced to just below significance after adjustment (RR 1.12, 95% CI 0.96–1.29).

Discussion

This study assessed the extent to which adjusting for prior mental health status affected the magnitude of the RR reported in studies of unemployment and suicide. Below we will discuss the main findings of the review and potential causal assumptions about mental health as a confounder, mediator or effect modifier of the relationship between unemployment and suicide.

Results of a random-effects meta-analysis demonstrated that the relationship between unemployment and suicide was attenuated after adjustment. Prior mental health made a significant contribution to the unemployment–suicide relationship as the RR due to unemployment declined by over 30% after these variables were considered. The review also suggests a dose–response relationship between exposure to

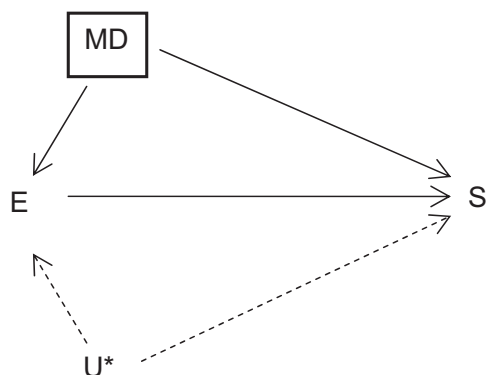


Fig. 3. Mental disorder (MD) as a common cause (confounder) of employment status (E) and suicide (S), with effect measure modification by an unknown unmeasured confounder/s (U^*). Adjustment is indicated by the square.

unemployment and suicide risk. Increased exposure to unemployment has been identified as a risk factor in two other recent studies (Milner *et al.* 2012, 2013b). The greatest risk of suicide is most likely to occur in the first 5 years following job loss (Milner *et al.* 2013b), possibly reflecting a longer-term ‘survivor bias’ where those most vulnerable to suicide die in the first 5 years following unemployment (Roelfs *et al.* 2011). Consistent with previous research, unemployment appears to be associated with greater suicide risk for males than females (Qin *et al.* 2000, 2003; Blakely *et al.* 2003; Milner *et al.* 2013a).

The reviewed cohort studies all assumed that mental health problems were common prior causes of unemployment and suicide (Fig. 3) and adjusted for these as confounding variables. This suggests that prior health increases the likelihood of later unemployment. The selection of healthy and unhealthy people into and out of the workforce, i.e. ‘healthy worker effect’ is also cited in studies showing that those with a history of mental health problems are often unemployed (Weich & Lewis, 1998; Brown *et al.* 2012; Butterworth *et al.* 2012). There is also evidence that people with impaired mental health are likely to lose their jobs or experience future unemployment (Paul & Moser, 2009; Butterworth *et al.* 2012), and that mental health issues are major risk factors for suicide (Bertolote *et al.* 2004). This evidence supports the premise that mental disorder can act as a confounder of the relationship between unemployment and suicide. In other words, unemployment may act as one additional factor that increases the vulnerability to suicide in those persons with pre-existing mental health problems.

Mental health problems may also be intermediary variables on the causal pathway from unemployment to suicide, reflecting the ‘social causation hypothesis’,

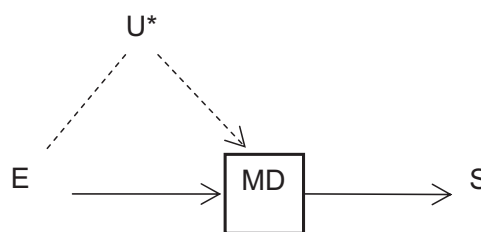


Fig. 4. Mental disorder (MD) as an intermediary of employment status (E) and suicide (S). U^* , Unmeasured confounders. Adjustment is indicated by the square.

which argues that unemployment creates heightened vulnerability for later mental illness and suicide (Hudson, 2005) (Fig. 4). As we noted in the Introduction, there is considerable evidence that mental health worsens after the loss of a job (Paul & Moser, 2009), which indicates that unemployment precedes both a decline in mental health and suicide. However, while conceptually plausible, adjustment for mental disorder as a mediator to assess the degree of attenuation of the association between unemployment and suicide (Baron & Kenny, 1986) is problematic as it induces selection bias by conditioning on a common effect (Kaufman *et al.* 2004). This is referred to as collider stratification bias (Greenland, 2003) where adjustment leads to biased estimates between the exposure and the outcome, due to the induced marginal association between unmeasured confounders and the exposure. This bias is particularly likely to make an impact on studies that do not include a measurement of the temporality of mental health issues and may be more likely to underestimate the effect of unemployment by assuming that mental illness occurred before (rather than after) job loss.

Alternatively, mental disorder may be an effect modifier of the association between unemployment and suicide. A nested cohort study in Denmark by Agerbo (2005) provides some empirical evidence for this situation. Results of a stratified analysis found that cases admitted for a psychiatric disorder who were unemployed had lower odds of suicide than those who were employed. In comparison, unemployment was associated with increased odds of suicide in the non-clinical general population. This study suggests that the negative influence of unemployment on suicide was most apparent in the general population, but had an inverse relationship among those with a history of mental disorder. Explanations for why unemployment was protective against suicide among people recently admitted (in the year before death) for a psychiatric disorder focused on stigma associated with diagnosis and the potential fear of job loss in the employed population.

The generalizability of the present review was limited by the inclusion of a small number of studies in relatively high-income and well-resourced countries in Europe. Study findings may therefore not extrapolate to poorer areas of the world with different cultural contexts. It is also worth noting that one of the reviewed studies (Lundin *et al.* 2012) had different findings from the other five studies included in the review. It was retained in analysis but it is acknowledged that the disparate results may bias the results away from the null. The design of all the reviewed cohort studies relied on exposure and outcome data collected from existing and routine hospital, health and mortality records. A problem with these types of retrospective cohort studies is that measurements of exposures and confounders can be quite crude and subject to possible misreporting. However, this bias is likely to be non-differential, with an equal likelihood of affecting both cases and controls. In spite of these limitations, the reviewed papers were based on national routinely collected health and mortality datasets and were the highest-quality studies available.

Consideration of the ways in which unemployment and mental disorder may be associated with suicide (as exposures, confounders, intermediaries, or effect modifiers) is important, as this will guide the appropriate analytic strategies required for unbiased (or least biased) estimates. A possible scenario could be a circumstance where a person who has co-morbid depression and alcohol abuse (caused at least in part by the depression) becomes unemployed, and as a result develops an anxiety disorder (unrelated to depression, but related to the reduced income associated with job loss) and starts drinking more heavily. To account for such a situation, the unbiased effect of unemployment (assuming no measurement error) associated with suicide would be the additive difference in risk associated with being unemployed compared with those employed in those with (compared with those without) alcohol abuse; that is, the interaction or joint effect of unemployment, adjusting for prior depression but not adjusting for anxiety.

The fact that these more complex scenarios are not present in the literature may reflect a lack of available data, as many cohort studies have to rely on officially reported information from health and employment registers. A more comprehensive understanding of the pathways by which unemployment influences suicide would require measurement of mental (and physical) illness at multiple points, including across the trajectory of working life, and before and after job loss. The use of causal graphs articulating possible exposure, confounding, intermediary and modifying factors can assist in the conceptualization of study design, measurement, and analytic strategy in studies

of the relationship between unemployment, mental illness and suicide (Shrier & Platt, 2008), clearly underscoring the importance of precise measurement of the temporal associations between exposures and outcomes.

In conclusion, our selected review of cohort studies indicates that unemployment is associated with greater risk of suicide after adjusting for prior mental disorder. We found that greater time spent unemployed was associated with greater risk of suicide. While the generalizability of this review is limited by the small number of studies, findings can be helpful at a policy level and support the idea that the period following job loss should be prioritized for prevention as a particularly high-risk time for suicide (Milner *et al.* 2012, 2013b). Future studies need to better conceptualize and measure the complex effects of job loss on suicide risk with attention to duration of unemployment and employment, assessment of mental health and illness before and after job loss, and interaction with life events such as relationship breakdown. These studies should also aim to combine information on individual risks with economic contextual influences at the macro-level. This is important because, as reported in past ecological studies, the relationship between unemployment and suicide at the individual level may be sensitive to overall labour market conditions (Corcoran & Arensman, 2011; Milner *et al.* 2012). A multi-level approach will allow interpretation at multiple levels of analysis, without committing the 'ecological fallacy' (Diez-Roux, 1998). Another important factor would be to assess whether mental health problems were a continuing problem or whether there was a recovery after treatment. This would aid in understanding the contribution of mental health to unemployment and eventual suicide. At the time of writing the present paper, none of the studies included in our meta-analysis displayed the data to support such an analysis. Such studies will be required in the future if researchers are to understand and articulate the complex relationships between unemployment, mental health and suicidality.

Supplementary material

For supplementary material accompanying this paper visit <http://dx.doi.org/10.1017/S0033291713001621>.

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Declaration of Interest

None.

References

- Agerbo E (2003). Unemployment and suicide: is the link always causal? *Journal of Epidemiology and Community Health* **57**, 560–561.
- Agerbo E (2005). Effect of psychiatric illness and labour market status on suicide: a healthy worker effect? *Journal of Epidemiology and Community Health* **59**, 598–602.
- Baron RM, Kenny DA (1986). The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* **51**, 1173–1182.
- Bertolote JM, Fleischmann A, De Leo D, Wasserman D (2004). Psychiatric diagnoses and suicide: revisiting the evidence. *Crisis* **25**, 147–155.
- Blakely TA, Collings SC, Atkinson J (2003). Unemployment and suicide. Evidence for a causal association? *Journal of Epidemiology and Community Health* **57**, 594–600.
- Brown J, Demou E, Tristram MA, Gilmour H, Sanati KA, Macdonald EB (2012). Employment status and health: understanding the health of the economically inactive population in Scotland. *BMC Public Health* **12**, 327.
- Butterworth P, Leach L, Pirkis J, Kelaher M (2012). Poor mental health influences risk and duration of unemployment: a prospective study. *Social Psychiatry and Psychiatric Epidemiology* **47**, 1013–1021.
- Corcoran P, Arensman E (2011). Suicide and employment status during Ireland's Celtic Tiger economy. *European Journal of Public Health* **21**, 209–214.
- Diez-Roux AV (1998). Bringing context back into epidemiology: variables and fallacies in multilevel analysis. *American Journal of Public Health* **88**, 216–222.
- Fergusson DM, Boden JM, Horwood LJ (2007). Unemployment and suicidal behavior in a New Zealand birth cohort: a fixed effects regression analysis. *Crisis* **28**, 95–101.
- Fergusson DM, Horwood LJ, Woodward LJ (2001). Unemployment and psychosocial adjustment in young adults: causation or selection? *Social Science and Medicine* **53**, 305–320.
- Glymour MM (2008). Causal diagrams. In *Modern Epidemiology*, 3rd edn (ed. K. Rothman, S. Greenland and T. L. Lash), pp. Lippincott Williams and Wilkins: Philadelphia.
- Greenland S (2003). Quantifying biases in causal models: classical confounding vs collider-stratification bias. *Epidemiology* **14**, 300–306.
- Harbord RM, Harris RJ, Sterne JA (2009). Updated tests for small-study effects in meta-analyses. *Stata Journal* **9**, 197–210.
- Hudson CG (2005). Socioeconomic status and mental illness: tests of the social causation and selection hypotheses. *American Journal of Orthopsychiatry* **75**, 3–18.
- Kaufman JS, Maclehorse RF, Kaufman S (2004). A further critique of the analytic strategy of adjusting for covariates to identify biologic mediation. *Epidemiologic Perspectives and Innovations* **1**, 4.
- Kraut A, Walld R (2003). Influence of lack of full-time employment on attempted suicide in Manitoba, Canada. *Scandinavian Journal of Work Environment and Health* **29**, 15–21.
- Lewis G, Sloggett A (1998). Suicide, deprivation, and unemployment: record linkage study. *British Medical Journal* **317**, 1283–1386.
- Li CY, Sung FC (1999). A review of the healthy worker effect in occupational epidemiology. *Occupational Medicine (London)* **49**, 225–229.
- Li Z, Page A, Martin G, Taylor R (2011). Attributable risk of psychiatric and socio-economic factors for suicide from individual-level, population-based studies: a systematic review. *Social Science and Medicine* **72**, 608–616.
- Lundin A, Hemmingsson T (2009). Unemployment and suicide. *Lancet* **374**, 270–271.
- Lundin A, Lundberg I, Allebeck P, Hemmingsson T (2012). Unemployment and suicide in the Stockholm population: a register-based study on 771,068 men and women. *Public Health* **126**, 371–377.
- Lundin A, Lundberg I, Hallsten L, Ottosson J, Hemmingsson T (2010). Unemployment and mortality – a longitudinal prospective study on selection and causation in 49321 Swedish middle-aged men. *Journal of Epidemiology and Community Health* **64**, 22–28.
- Maki N, Martikainen P (2012). A register-based study on excess suicide mortality among unemployed men and women during different levels of unemployment in Finland. *Journal of Epidemiology and Community Health* **66**, 302–307.
- Milner A, Hjelmeland H, Arensman E, De Leo D (2013a). Social and environmental factors and suicide mortality: a narrative review of over 200 articles. *Sociology Mind* **3**, 137–148.
- Milner A, Page A, Lamontagne AD (2012). Duration of unemployment and suicide in Australia over the period 1985–2006: an ecological investigation by sex and age during rising versus declining national unemployment rates. *Journal of Epidemiology and Community Health* **67**, 237–244.
- Milner A, Page A, Lamontagne AD (2013b). Long-term unemployment and suicide: a systematic review and meta-analysis. *PLOS ONE* **8**, e51333.
- Morrell S, Taylor R, Quine S, Kerr C, Western J (1999). A case-control study of employment status and mortality in a cohort of Australian youth. *Social Science and Medicine* **49**, 383–392.
- Mortensen PB, Agerbo E, Erikson T, Qin P, Westergaard-Nielsen N (2000). Psychiatric illness and risk factors for suicide in Denmark. *Lancet* **355**, 9–12.
- Paul KI, Moser K (2009). Unemployment impairs mental health: meta-analyses. *Journal of Vocational Behavior* **74**, 264–282.
- Platt S (1984). Unemployment and suicidal behaviour: a review of the literature. *Social Science and Medicine* **19**, 93–115.

- Qin P, Agerbo E, Mortensen PB** (2003). Suicide risk in relation to socioeconomic, demographic, psychiatric, and familial factors: a national register-based study of all suicides in Denmark, 1981–1997. *American Journal of Psychiatry* **160**, 765–772.
- Qin P, Agerbo E, Westergaard-Nielsen N, Eriksson T, Mortensen PB** (2000). Gender differences in risk factors for suicide in Denmark. *British Journal of Psychiatry* **177**, 546–550.
- Roelfs DJ, Shor E, Davidson KW, Schwartz JE** (2011). Losing life and livelihood: a systematic review and meta-analysis of unemployment and all-cause mortality. *Social Science and Medicine* **72**, 840–854.
- Sanderson S, Tatt ID, Higgins JP** (2007). Tools for assessing quality and susceptibility to bias in observational studies in epidemiology: a systematic review and annotated bibliography. *International Journal of Epidemiology* **36**, 666–676.
- Shah D** (2009). Healthy worker effect phenomenon. *Indian Journal of Occupational and Environmental Medicine* **13**, 77–79.
- Shrier I, Platt R** (2008). Reducing bias through directed acyclic graphs. *BMC Medical Research Methodology* **8**, 70.
- Weich S, Lewis G** (1998). Poverty, unemployment, and common mental disorders: population based cohort study. *British Medical Journal* **317**, 115–119.
- Yoshimasu K, Kiyohara C, Miyashita K** (2008). Suicidal risk factors and completed suicide: meta-analyses based on psychological autopsy studies. *Environmental Health and Preventative Medicine* **13**, 243–256.