

Title

Suicidal Ideation and Mental Health Conditions in the Construction Industry: A Meta-Analysis

Acknowledgements

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Authors

Simon Tyler

Supervisor

Professor Deborah Turnbull, Affiliations - Freemasons Foundation Centre for Men's Health, University of Adelaide, Adelaide, South Australia and School of Psychology, University of Adelaide, Adelaide, South Australia.

Submission

This paper is intended to be submitted to Crisis (<https://us.hogrefe.com/products/journals/crisis>) an international periodical that publishes original articles on suicidology and crisis intervention. The journal requirements and author submission guidelines are provided in the accompanying document entitled Crisis Submission Guidelines for Authors. To fulfil journal requirements all information attached in appendices will be available via online platforms as supplementary data. Additionally, while Crisis does not explicitly state submitted articles need to adhere to a word limit, to make the article more succinct and appealing to publishers, some aspects of the introduction will be modified to reduce word count. Reduction of suicide related concepts, facts and figures will be reduced as readers of this publication are aware of these facts and figures. Furthermore, the method will be reduced with significant focus being placed on the data extraction and statistical analysis sections to reduce word limit as some parts are required for appropriate assessment for the master's thesis but not needed for publication.

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Abstract

Background: With reports of significant global suicide rates suggestion is that research of suicidal ideation and mental health conditions, as well as identification of alternative “at-risk” populations is an effective research direction. While the construction industry has been suggested to have higher rates of suicide in comparison to the general working population, little research or synthesis of current knowledge has been undertaken focussing on suicidal ideation and mental health condition prevalence and rates for this population.

Aims: To summarise current understandings of prevalence and rates of suicidal ideation and mental health conditions in the construction industry, as well as identify possible methodological limitations in the area.

Method: Random effects meta-analyses were used to calculate pooled prevalence, odds and risks of mental health conditions for those employed in the construction industry.

Results: Thirteen studies investigating mental health conditions in the construction industry were included in the meta-analysis. No articles regarding suicidal ideation were identified. Pooled prevalence rates suggested a slight increase in mental health conditions for those employed in the construction industry (17.5%, CI95% = 11.7-22.5%) in comparison to suggested global rates, with an increase observed when adjusting for non-clinical assessments of mental health conditions (19.2%, CI95% = 12.9-27.7%) and when adjusting for both for non-clinical assessments of mental health conditions and underrepresentation of sample (20.1%, CI95% = 11.9-32.1%). Pooled Odds Ratio's (OR) suggested no greater odds of experiencing a mental health condition for those employed in the construction industry (OR = 1.412, CI95% = 0.798–2.499), however, when adjusting for underrepresentation of sample, a statistically significant OR was observed (OR = 1.050, CI95% = 1.011–1.091). Pooled Risk Ratio's (RR) suggested no increased risk of mental health conditions in the construction industry (RR = 1.068, CI95% = 0.875–1.304), a finding also observed when adjusting for

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non-clinical assessments of mental health conditions (RR = 1.443, CI95% = 0.549–3.791), or underrepresentation of sample (RR = 1.511, CI95% = 0.651–3.507).

Conclusions: This is the first comprehensive meta-analytical review of suicidal ideation and mental health conditions in the construction industry and highlights the need for greater amounts of research and use of standardised methodologies in this area. The current study suggests a slightly increased prevalence and odds of mental health conditions experienced by construction workers however, further research is required to confirm these suggestions.

Introduction

Suicide is a significant global health issue with the World Health Organisation (WHO) estimating that globally 800,000 suicides occur each year (WHO, 2018). While this number is likely to be an underestimation due to associated classification issues (e.g., misappropriation), suicide continues to create significant socioeconomic burden with negative physical, psychological and economic outcomes reported (De Leo, 2015; Bolton, Au, Leslie, Martens, Enns, Roos, . . . & Sareen, 2013; Florence, Simon, Haegerich, Luo, & Zhou, 2015; Pitman, Osborn, King, & Erlangsen, 2014; Shepard, Gurewich, Lwin, Reed, & Silverman, 2016). While research has identified a range of “at-risk” populations, including individuals of a younger age, male gender and lower socioeconomic status, leading to programme and policy development, suicide rates have increased by 60% percent over the past 45 years (e.g., ABS, 2019; Koo, McDonough, & Ross, 2016; Milner, Spittal, Matthew, Pirkis, & LaMontagne, 2013; WHO, 2018). Resultingly, it is suggested that the identification of conditions that may provide intervention opportunities, as well as detection of more specific “at-risk” populations are important research directions (Pu, Setoyama, & Noda, 2017; Jobes & Joiner, 2019).

Subsequently, scholars have suggested that suicide morbidity is the “tip of the iceberg” and suicidal ideation and mental health conditions require focus to address this increasing issue (Pu et al., 2017; Jobes et al., 2019). While it is recommended that research treats these issues as separate constructs, as there are often differences in etiology, risk and protective factors, and that one issue can occur without presence of the others, evidence supports an association between suicide, suicidal ideation and mental health conditions (Brent, 2002; Pu et al, 2017; Jobes, & Joiner, 2019; Runeson, & Asberg , 2003). Research, such as psychological autopsies, a protocol driven technique where events proceeding suicide are analysed (e.g., family interviews), have suggested as many as one third of those who experience suicidal ideation will later attempt suicide and the more severe the ideation the more likely an attempt (e.g., Chan, Shamsul, & Maniam, 2014; McHugh, Corderoy,

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Ryan, Hickie, & Large, 2019; Wetherall, Cleare, Eschle, Ferguson, O'Connor, O'Carroll, & O'Connor, 2018). Additionally, meta-review evidence indicates that presence of a mental health condition results in a significant increase in suicide mortality, a finding supported by re-analysis of a United Kingdom based sample of close to 500,000 individuals (Batty, Kivimäki, Bell, Gale, Shipley, Whitley, & Gunnell, 2018; Chesney, Goodwin, & Fazel, 2014). While it is acknowledged that there is conjecture within the literature regarding the magnitude of the association between suicide, suicidal ideation and mental health conditions, the expression of either suicidal ideation or mental health conditions does allude to an individual's current level of psychological distress and therefore greater propensity to suicide (e.g., McHugh et al., 2019). As such, knowledge of said conditions may create intervention opportunities and therefore is suggested to be an avenue to effectively address and prevent suicide (e.g., Pu et al, 2017; Jobes et al., 2019; Wang, Swaraj, Chung, Stanton, Kapur, & Large, 2019).

Aside from their association to suicide, the prevalence and socioeconomic impact of suicidal ideation and mental health conditions indicate the importance of research that aims to identify populations at greater risk and gather information that aims to mitigate their influence. Research suggests that within the United States alone, annually 10.6 million individuals experience suicidal ideation (SAMHSA, 2018). While no research has quantified suicidal ideation's economic impact, given Major Depressive Disorder (a condition often comorbidly experienced with suicidal ideation) costs the United States alone \$210 billion, expectation is of a significant burden (e.g., Crosby, Ortega, & Melanson, 2011; Greenberg, Fournier, Sisitsky, Pike, & Kessler, 2015; Van Spijker, Majo, Smit, Van Straten, & Kerkhof, 2012). Similarly, mental health condition prevalence within society is substantial with estimations that globally around 13% of the population are experiencing a mental health condition (Stanaway, Edvardsson, & Murray, 2018). Mental health conditions are shown to affect an individual's daily functioning, overall physical health and interpersonal relationships with economic

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impacts not only for the healthcare sector but for business, with mental health conditions shown to cost Australian business \$11 billion dollars annually (Bluff, 2016; Price Waterhouse Coopers, 2014).

Following recommendation for identification of more specific “at-risk” populations, research has demonstrated that certain occupation/industries are shown to be associated with greater suicide rates (Milner et al., 2013). The construction industry has been identified as “at-risk” with meta-analytic research suggesting employees are at elevated risk of suicide when compared with the working-age population (Milner et al., 2013). This research has been vital in identifying the need for focus on understanding the possible drivers of suicide in the construction industry. At present, suggestions are that the fluctuating nature of the construction industry, which creates job uncertainty and a lack of financial security, the high pressure, physical and repetitive nature of industry roles and expectation to work long hours as possible drivers (e.g., Han, et al., 2016; LaMontagne et al., 2008; Milner et al., 2016; Nishimura et al., 2004; Schneider, et al., 2011; Woo et al., 2008). Additionally, a recent focus has been placed on the role of masculinity with the construction industry male dominated the possibility of industry influence on masculine expectation adherence is a viable concept (Milner et al., 2017).

While the above suggestions may prove viable, at present they remain theoretical until further research is undertaken to discern their validity. Furthermore, research focussing on two factors already highlighted by scholars as important to suicide prevention, being suicidal ideation and mental health conditions, remains underdeveloped in the construction industry. For example, a 2014 beyondblue report provided a review of depression and anxiety in blue collar workers and identified only four studies that examined this area (Roche, Lee, Pidd, Fischer, Battams, & Nicholas, 2014). While this review was undertaken 5 years ago and did not incorporate other mental health conditions associated with suicide, an approach that may allow for a more in depth understanding, the lack of knowledge regarding suicidal ideation and mental health conditions in an industry

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suggested to be at greater risk of suicide is of concern, particularly given the suggestion of their significance in suicide prevention (McHugh et al., 2019; Pu et al, 2017; Jobes, & Joiner, 2019).

With research in the area of suicidal ideation and mental health conditions in the construction industry not effectively synthesised, as well as the suggestion that the importance of knowledge surrounding these issues may allow for suicide intervention opportunities, the current study intends to clarify some key aspects in this area. Using meta-analysis, the current study will provide information on whether, similar to suicide, there is an increased prevalence, odds and risk of suicidal ideation or mental health conditions in the construction industry. Additionally, the use of meta-analysis will lead to identification of methodological limitations that may be present in past research approaches, allowing for guidance of better practices as the area of research develops.

Method

Search strategy

The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prisma) statement and registered with Prospero (Identification Number: 136365) to avoid duplication (Moher, Liberati, Tetzlaff, & Altman, 2009). The search strategy, developed in consultation with an experienced medical librarian, was designed to access articles that reported information on suicidal ideation and mental health conditions in the construction industry. Additionally, to minimise the likelihood of not capturing articles assessing outcomes related to suicidal ideation, suicide and related terms (e.g., suicidal behaviour) were included in the search strategy. Computer-based internet databases used for this search included Medline (Pubmed), Psycinfo, Embase and Scopus. The combinations of keywords used included terms such as suicide*, suicidal ideation*, mental disorder* and construction industr*, construction trade*, construction worker* and full search strategies for respective databases are attached in

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Appendix A. A secondary search examined both grey literature and reference lists of retained articles with both published and unpublished reports considered in the review process.

Eligibility criteria and selection of studies

Only studies that had key search terms in the title or abstract and suicidal ideation or mental health conditions, not including alcohol or substance use issues, as outcomes were considered. Non-empirical and non-English articles were excluded. The study population of interest was those employed in the construction industry and therefore classification of appropriate study population was based on an explicit article statement that the analysed sample was represented by those employed in this industry alone. This meant that articles that incorporated construction industry workers with other occupations, such as mining and extraction, for the purpose of analysis were excluded. Qualitative studies were reviewed for narrative synthesis, leaving descriptive cohort studies, retrospective population-level studies, case-control studies, meta-analyses and systematic reviews to be statistically analysed. All effect-size estimates were considered eligible, including Odds Ratios (ORs), Risk Ratios (RRs), Relative Risk Ratios (RRR) and Hazard Ratios, as were descriptive reports of prevalence rates.

Data extraction

Initial data searches and deletion of article duplicates were conducted by Simon Tyler (ST) supported by consultation with an experienced medical librarian. First stage data screening of title and abstracts were completed by two reviewers, ST and Hugh Gockowiack (HG), to minimize selection bias and related errors. ST and HG completed checks of remaining article reference lists, with articles assessed as relevant included in next stage of review. ST and HG conducted full text reviews of remaining articles and following article deletion both ST and HG undertook independent data extraction. At all stages of review any mismatched study classifications or data extraction

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discrepancies were resolved by consensus between ST and HG, supported by the understanding that if consensus could not be achieved resolution would be overseen by Professor Deborah Turnbull, however, this was not required. Information extracted from each study included the location of the study, time period the study was conducted, author names, description of occupation, description of the comparison population (or control group), effect size, confidence intervals and/or standard error and prevalence rates for suicidal ideation or mental health conditions.

Quality Assessment

Papers were assessed for quality using the Mixed Methods Assessment Tool (MMAT; Hong et al., 2018). The MMAT allows for the assessment of a range of study designs and therefore was considered appropriate given the different methodologies employed by included articles (Hong et al., 2018). Quality assessment was independently undertaken by ST and HG. Any disputes were resolved by consensus between ST and HG, supported by the understanding that if consensus could not be achieved, resolution would be overseen by Professor Deborah Turnbull, however this was not required.

Statistical analysis

Prevalence rates reported by person-years were standardised to rates per 100 to facilitate pooling in the meta-analysis with assistance from Dr. Phillip Tully (Freemason Foundation Centre for Men's Health). Random effects modelling was undertaken on pooled prevalence rates to give greater control of heterogeneity between studies, providing a more unbiased account of prevalence rates of mental health conditions in construction workers. Random effects moderator analysis adjusting for studies deemed as having non-clinically defined outcomes (e.g., need for recovery) were undertaken and followed by another analysis using the same methodology which adjusted for

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both non-clinical outcomes as well as studies reporting samples deemed as under-representative of the construction industry (e.g., only analysing one type of construction occupation e.g., bricklayers).

As the result of identified heterogeneity, reported effect sizes were pooled based on similarity of effect size outcome. Three articles reporting Odds Ratio (OR) effect sizes were pooled and analysed. Additionally, the three articles that reported Standardised Incidence Rate Ratio (SIRR), Incidence Rate Ratio (IRR) and a Relative Risk Ratio (RRR) as effect sizes were pooled and analysed, as these effect sizes are seen as comparable due to their measure of Risk Ratios (RR). Where effect size confidence intervals were unavailable, these were calculated using the standard error of the effect size. Again, random effects models were generated to assess pooled OR's and RR's to allow for greater control of heterogeneity.

A random effects moderator analysis was conducted on pooled OR effect sizes to adjust for studies that reported under-representation of the construction industry in sample. No further analysis adjusting for non-clinical measures was undertaken as all articles reporting OR's used measures deemed appropriate. Random effects moderator analyses were undertaken on pooled RR effect sizes, with the first adjusting for studies deemed as having non-clinically defined outcomes (e.g., need for recovery), followed by another which adjusted for samples deemed as under-representative of the construction industry (e.g., only analysing one type of construction occupation e.g., bricklayers). These random effects model analyses were conducted independently due to the low numbers of articles reporting RR effect sizes, limiting the ability to combine these analyses.

All data were analysed using the Comprehensive Meta-Analysis programme and tables were developed in GraphPad Prism version 8.00 for Windows (Borenstein, Hedges, Higgins, & Rothstein, 2013; GraphPad Software, 2018).

Results

Study selection

Search strategies identified a total of 2044 articles (Fig. 1 & Appendix A). Initial scan of title and abstracts led to exclusion of duplicates, editorial and non-empirical pieces. Review of the abstracts of the remaining 234 studies resulted in exclusion of a further 81 articles due to incorporation of construction employees with other industries during analysis, being individual case studies or having suicide or drug and alcohol issues as outcomes (leaving only articles on suicidal ideation and mental health conditions). Following this, 153 full-text articles were read for inclusion along with an additional 15 articles identified from reference lists. At the last stage of review, 165 articles were excluded due to incomplete reporting of effects and/or lack of explicit statement that construction was analysed samples industry of employment and/or having outcomes not of focus to the current study. Only one article was identified with suicidal ideation as an outcome, published in a non-English format, therefore no further analysis was conducted for this topic. This left 13 eligible studies with mental health conditions as outcomes to be analysed.

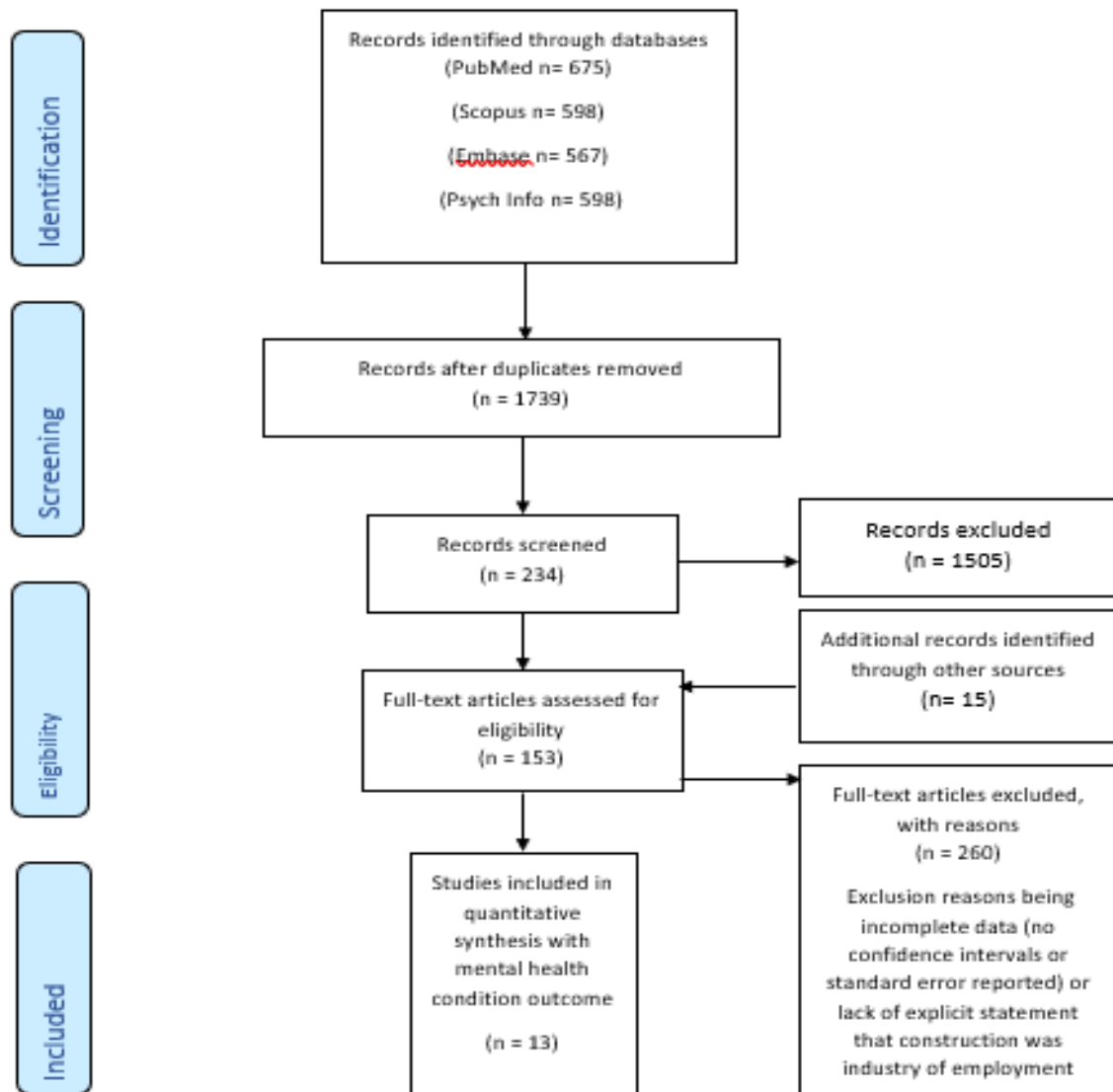


Figure 1: Selection of studies for meta-analysis

Study Characteristics

Thirteen studies investigated the prevalence rates and effect sizes of mental health conditions in the construction industry and investigation was undertaken in various locations including the United States,^{7,8,9,12} Netherlands,^{2,10} United Kingdom,⁵ Australia,⁶ China,¹ France,⁴ Korea,¹¹ Germany,¹³ and Sweden³. A range of different measures to assess the presence of a mental health condition were used including; Self-reported suicidal ideation, neurosis, psychoneurosis, anxiety, neurotic depression or asthenia episodes causing sick leave > 30 days;³ Self-reported

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distress or need for recovery;¹⁰ Doctor diagnosis of International Classification of Diseases 10 mental distress/burnout² or mental health disorders;^{4,13} Doctor diagnosis of emotional or mental health conditions;^{5,7} Diagnostic and Statistical Manual of Mental Disorders III diagnosis of schizophrenia⁸ or major depressive disorder;¹² Above clinically defined cut off scores on the - Kessler Psychological Distress Scale (K10);⁶ Centre for Epidemiological Studies-Depression (CES-D);¹¹ The State-Trait Anxiety Inventory (STAI);¹¹ The Hopkins Symptoms Checklist (HSCL);⁹ Profile of Mood States depression (POMSd)¹ (Andrews, & Slade, 2001; McNair, Lorr, & Doppleman, 1971; Parloff, Kelman, & Frank, 1954; Radloff, 1977; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). As mentioned above construction is a male dominated industry and therefore in many studies only males were included in the sample or females were excluded due to low rates.^{1,2,3,5,6,7,13} Other articles examined all persons, however numbers of females in the samples remained small.^{4,8,9,10,11,13} Primarily prevalence rates of mental health conditions in analysed samples were reported,^{1,2,3,6,9,10,11} however three articles reported Odd Ratios (OR),^{4,7,12} one article a Standardised Incidence Rate Ratio (SIRR),¹³ one an Incidence Rate Ratio (IRR)² and one a Relative Risk Ratio (RRR)⁸. In those articles that reported effect sizes a range of referent populations were used including a developed case control group,¹² those categorised as white collared workers⁷ and all other occupation groups.^{2,4,8,13}

Quality Assessment

As mentioned, the current study used the Mixed Methods Assessment Tool (MMAT) to assess the quality and bias of each article for the meta-analysis (Hong et al., 2018). The MMAT developers suggest that while removal of papers based on low methodological quality is inappropriate, it does allow for moderation of articles in further analysis based on detailed inspection of paper quality, guided by the different domains of assessment, and author judgement (Hong et al., 2018). Following assessment some issues were identified in a small subset of included papers. As mentioned above there were a range of measures used to assess the presence of mental

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health conditions across the studies. While the majority were considered acceptable due to being assessed on empirically supported measures, others were deemed as less suitable due to definition of mental health condition presence being based on non-clinically defined outcomes (e.g., need for recovery). Additionally, some samples were deemed as not completely representative of the construction industry population. Some articles only sampled participants from one aspect of the industry (e.g., apprentices or one type of construction occupation e.g., bricklayers) and therefore these samples cannot be deemed as completely representative of the construction industry. Despite these identified issues, most papers were deemed as methodologically sound and the subsequent analyses attempted to control for any issues mentioned above. An account of the included studies and their ability to meet defined criterion can be found in the tables located in Appendix B.

Heterogeneity

Funnel plots were generated for all pooled analyses, located in Appendix D, however these plots provide limited information due to small numbers of studies that qualified for analysis and therefore interpretation must be treated with caution. Inspection of fixed effects models of all pooled analyses suggested significant heterogeneity between studies (all pooled analyses $I^2 = > 60$), possibly the result of varied sample sizes, study designs and differences in outcome measures, therefore random effects models were generated to best control for this issue (e.g., Higgins, & Thompson, 2002).

Prevalence of Mental Health Conditions in the Construction Industry

Results for each of the 8 included studies can be found in Appendix C, and Figure 2. shows each article's standardised event rates and confidence intervals. Standardised event rates (per 100 individuals) ranged from 0.003 (CI95% = 0.000-0.090; Van Der Molen et al., 2016) to 0.36 (CI95% = 0.272-0.458; Zheng et al., 2010). Following assessment of fixed effect models which demonstrated significant heterogeneity ($I^2 = > 80$), a random effects model of pooled results was generated, also

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shown in Figure 2. and represented on forest plot line titled Random Effects Model. This model indicated the pooled prevalence rates from the assessed articles was 0.175 (CI95% = 0.117-0.255) suggesting a mental health condition prevalence rate of approximately 17.5 % for the assessed construction industry sample.

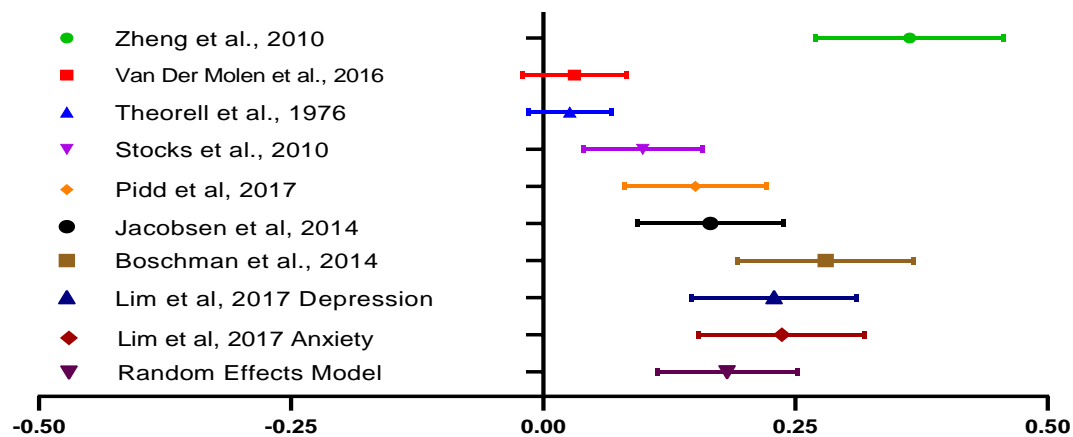


Figure 2. Prevalence of mental health in construction industry: Forrest plot of article results and pooled random effects model. Fixed effects model $I^2 = 81.09$.

A moderator analysis was undertaken to adjust for articles deemed as having non-clinical assessments of mental health conditions; 2 as a result of self-reported outcomes (Theorell et al., 1976 & Boschman et al., 2014) and one as a result of classification of a mental health condition being based on stress/fatigue rather than a clinically defined condition like depression or anxiety (Van Der Molen., et al 2016). Using a random effects analysis, with results shown in Figure 3. and represented by forest plot line labelled Random Effects Model 1, pooled prevalence rates increased to 0.192 (CI95% = 0.129-0.277). This suggests that when adjusting for non-clinical assessments, there are mental health condition prevalence rates of approximately 19.2% for the sample of construction workers assessed by clinical measures.

A final moderator analysis on prevalence data was completed to adjust for studies deemed as having either non-clinical assessments of mental health conditions or samples with less than desired representation of the construction industry population. Moderation of articles was based on

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1 demonstrating self-reported outcomes (Theorell et al., 1976), 1 as a result of classification of a mental health condition being based on stress/fatigue rather than a clinically defined condition like depression or anxiety (Van Der Molen., et al 2016), 1 as a result of both self-reported outcome and poor representation of sample (Boschman et al., 2014) and 1 as a result of poor representation of sample (Pidd et al., 2017). Again, random effects analysis was used, with results shown in Figure 3. and represented by forest plot line labelled Random Effects Model 2. The analysis indicates pooled prevalence rates increased to 0.201 (CI95% = 0.119-0.321). This suggests that mental health condition prevalence rates increase to approximately 20% for the analysed sample of construction workers when adjusting for either non-clinical assessments of mental health conditions or samples with less than desired representation of the construction industry.

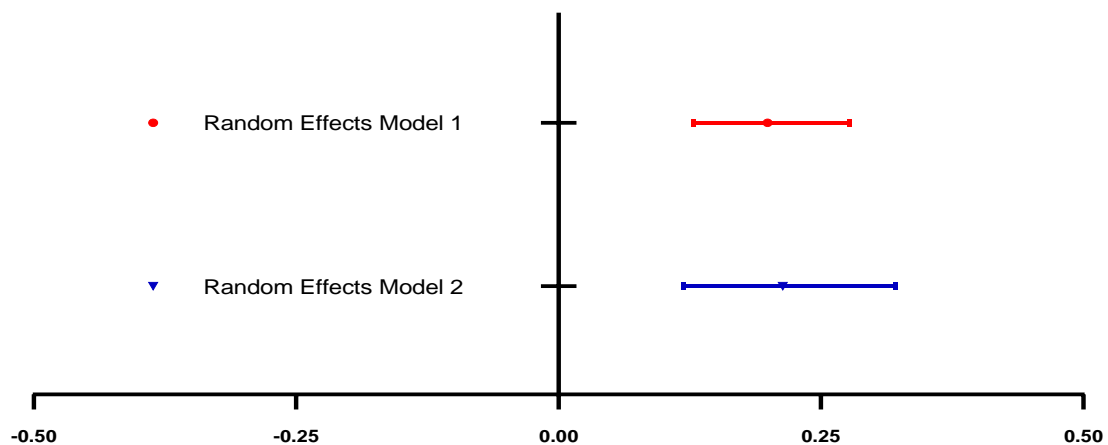


Figure 3. Pooled prevalence rates following control for study methodology. **Random Effects Model 1** – Pooled prevalence rates of articles using clinically defined measures of mental health conditions in construction industry. Fixed effects model $I^2 = 80.70$ **Random Effects Model 2** – Pooled prevalence rates of articles using clinically defined measures of mental health conditions and samples with representative of the construction industry. Fixed effects model $I^2 = 82.16$.

Odds Ratios of Mental Health Conditions in the Construction Industry

The three articles that reported Odds Ratio (OR) effect sizes are displayed below in Figure 4. Two articles reported statistically significant ORs with Telle-Lamberton et al., (2018) reporting an OR of 1.05 (95%CI = 1.01-1.09) and Peterson et al., (1998) an OR of 2.146 (95%CI = 1.433-3.200) for those within the construction industry when compared to the general working population.

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Conversely, Eaton et al., (1990) reported an insignificant OR for those in the construction industry (OR = 1.254, 95%CI = 0.440-3.575) in comparison to a developed case control group. Following assessment of pooled OR's through a fixed effect model, which demonstrated significant heterogeneity ($I^2 = > 69$), a random effects model was generated, shown on Figure 4. via forest plot line labelled Random Effects Model 1; however, this indicated an insignificant OR of 1.412 (95%CI = 0.798-2.499) for pooled results across the three studies.

A moderator analysis on pooled OR data was completed to adjust for studies deemed as having non-clinical assessments of mental health conditions or samples with less than desired representation of the construction industry; 1 study was adjusted for as a result of poor representation of sample (Peterson et al., 1998). A random effects model was generated, and results are shown in Figure 4., represented by forest plot line labelled Random Effects Model 2, with the OR increasing to 1.050 (CI95% = 1.011-1.091) suggesting a statistically significant OR for the sample of construction workers when adjusting for poor sample representation.

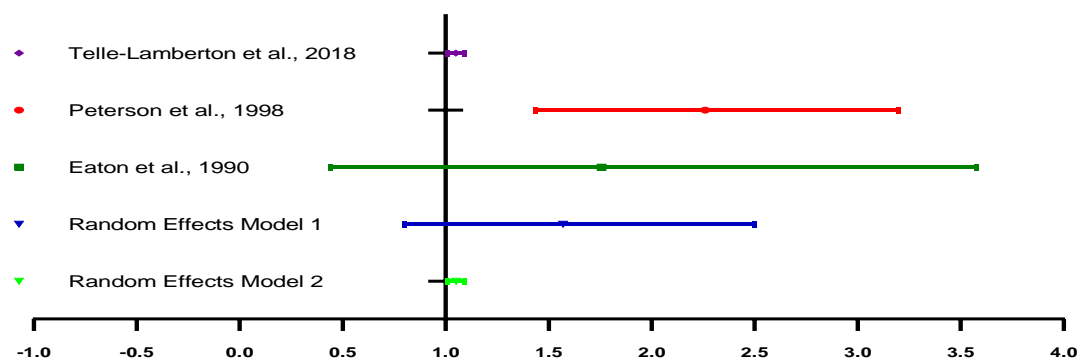


Figure 4. Odds Ratio effect sizes of mental health in construction industry. Forrest plot of article results and pooled random effects models. **Random Effects Model 1** – Pooled prevalence rates of articles reporting OR outcomes for mental health conditions in construction industry. Fixed effects model $I^2 = 83.551$; **Random Effects Model 2** – Pooled prevalence rates of articles using clinically defined measures of mental health conditions and samples with representative of the construction industry. Fixed effects model $I^2 = 82.16$.

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Risk Ratios of Mental Health Conditions in the Construction Industry

The three articles that reported Risk Ratio (RR) effects sizes are displayed below in Figure 5. One article reported a statistically significant RR with Muntaner et al., (1991) indicating an increased risk of mental health conditions in the construction industry (RR = 2.58, CI95% = 1.15-5.77) in comparison to a population of white collared workers. Conversely, two articles reported insignificant RRs with Van Der Molen et al., (2016) reporting a RR of 1.07 (95%CI = 0.98-1.11) and Ardnt et al., (2015) reporting a RR of 0.95 (95%CI = 0.81-1.11) for those employed within the construction industry when compared to the general working population. Following assessment of pooled RR's through a fixed effect model which demonstrated significant heterogeneity ($I^2 = > 80$), a random effects model was generated; however, this indicated an insignificant RR of 1.068 (95%CI = 0.875-1.304) for pooled results across the three studies also shown in Figure 5. and represented by the forest plot line labelled Random Effects Model 1.

Additional moderator analyses were conducted on pooled RR data. The first analysis was completed to adjust for studies deemed as having non-clinical assessments of mental health conditions with 1 article, Van Der Molen., et al (2016), fitting this description. A random effects model was generated; results are shown in Figure 5. and represented by forest plot line labelled Random Effects Model 2, with the RR remaining insignificant at 1.443 (CI95% = 0.549-3.791). The second analysis was completed to adjust for studies that included samples with less than desired representation of the construction industry. Again, a random effects model was generated, with results shown in Figure 5. and represented by forest plot line labelled Random Effects Model 3, with the RR again remaining insignificant (RR = 1.511, CI95% = 0.651-3.507). These analyses were completed separately due to the minimal literature available reporting RRs.

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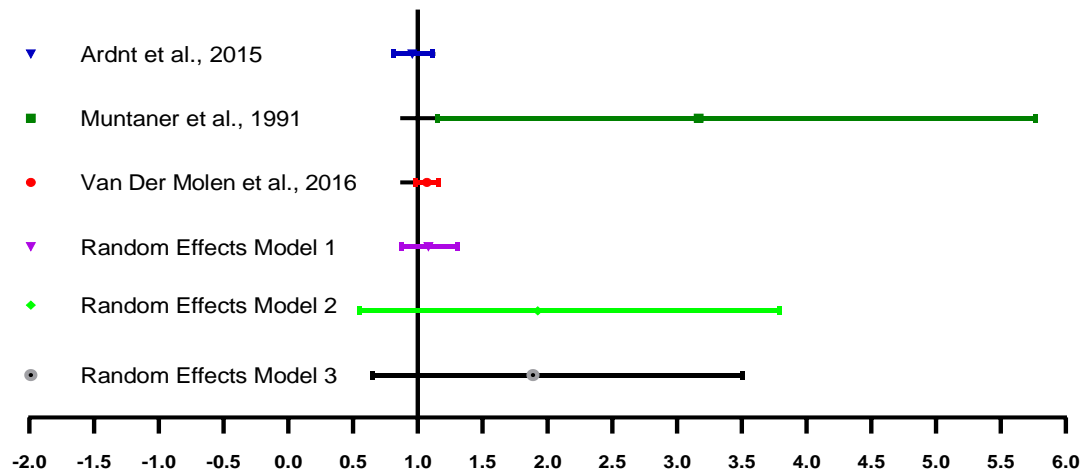


Figure 5. Risk ratio effect sizes of mental health in construction industry. Forrest plot of article results and pooled random effects models. **Random Effects Model 1** – Pooled prevalence rates of articles reporting RR outcomes for mental health conditions in construction industry. Fixed effects model $I^2 = 69.31$. **Random Effects Model 2** – Pooled prevalence rates of articles using clinically defined measures of mental health conditions and samples with representative of the construction industry. Fixed effects model $I^2 = 82.39$. **Random Effects Model 3** – Pooled prevalence rates of articles using samples representative of the construction industry. Fixed effects model $I^2 = 77.91$

Discussion

Suicide is a significant global health issue and despite efforts, rates continue to increase (WHO, 2018). Subsequently, scholars have recommended for research to focus on identification of alternative “at-risk” populations, as well as suicidal ideation and mental health conditions, as knowledge in these areas may allow for more effective intervention opportunities and overall reduction of associated socioeconomic burdens (Batty, Kivimäki, Bell, Gale, Shipley, Whitley, & Gunnell, 2018; Chesney, Goodwin, & Fazel, 2014; McHugh, Corderoy, Ryan, Hickie, & Large, 2019; Jobes, & Joiner, 2019; Pu et al., 2017; Jobes et al., 2019; Runeson, & Asberg, 2003; Wetherall, Cleare, Eschle, Ferguson, O'Connor, O'Carroll, & O'Connor, 2018).

With research suggesting the construction industry has increased suicide rates in comparison to the general working population, theories regarding drivers of this increased rate have been proffered (Milner et al., 2017). However, little focus has been placed on suicidal ideation and

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mental health condition prevalence and rates in this area, surprising given the suggestion this is an important avenue for mitigation of suicide (Roche, Lee, Pidd, Fischer, Battams, & Nicholas, 2014).

Subsequently, the current study provides an updated understanding of the prevalence and rates of suicidal ideation and mental health conditions in the construction industry, as well as allowing for evaluation of methodological issues in this developing area (McHugh et al., 2019; Pu et al, 2017; Jobes, & Joiner, 2019).

Research of Suicidal Ideation and Mental Health Conditions in the Construction Industry

This study confirms the lack of research investigating suicidal ideation in the construction industry. The search strategy was developed with an understanding that search terms needed to be broad enough to capture all articles that focussed on suicidal ideation. To ensure no articles were missed the search strategy included suicide and related terms, which significantly increased the amount of literature captured, however, despite this only one non-English article was identified. With scholars suggesting that research regarding suicidal ideation is an important direction for suicide prevention this lack of literature is of concern (Pu et al, 2017; Jobes, & Joiner, 2019). The authors of this article recommend that future investigations of suicide and/or mental health conditions in the construction industry also place focus on suicidal ideation to develop greater knowledge and understanding of its relevance in this space.

Additionally, while in comparison to suicidal ideation research, the amount of literature focussing on mental health conditions in the construction industry was far more substantial, the need for further research remains. A total of thirteen articles were identified and substantial differences in methodologies can be seen. A wide variety of outcome measures were used, and, in some cases, these could be deemed as unsuitable due to their non-clinical nature. Additionally, some issues with population underrepresentation in samples were identified. While the current

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study did attempt to control for these issues and makes comment on this later in this discussion, the minimal amount of literature, particularly presenting information on effect sizes, restricted the analysis in many ways. As such the need for a more standardised approach, as well as an increase in the overall amount of research focussing on suicidal ideation and mental health conditions in the construction industry is recommended.

Main Findings

Mental Health Condition Prevalence in the Construction Industry

Results suggest a slightly increased prevalence rate of mental health conditions in the construction industry. While different rates of mental health condition prevalence in the general population are reported, currently estimates are that 13% of the population experience a mental health condition (Stanaway, Edvardsson, & Murray, 2018). In comparison, the current study's pooled estimates suggest the prevalence rates of mental health conditions in the construction industry as slightly raised. Additionally, when adjusting for studies that were deemed as having non-clinical assessments of mental health conditions, prevalence rates increased, a result also observed when adjusting for studies deemed as having either non-clinical assessment of mental health conditions or underrepresentation of construction workers in the analysed population. Furthermore, the current analysis did not include papers that had substance use or alcohol issues as outcomes possibly affecting the pooled prevalence rates reported.

Overall, these results suggest a slightly increased prevalence rate of mental health conditions within the construction industry. While we cannot make suggestions that this is related to the increased suicide rate reported in the construction industry, as well as acknowledging that results need to be interpreted with caution, due to some confidence intervals overlapping reported general population rates, it does suggest that further research in this area would be worthwhile.

Odds and Risk Ratios of Mental Health Conditions in the Construction Industry

While the pooled analysis of articles reporting odds ratios did not report greater odds of experiencing a mental health condition for those employed in the construction industry when compared to either a general working or case control population, when adjusting for underrepresentation of construction workers in study samples, this suggestion changes. While the increased odds reported are not large, they are statistically significant, adding support to the suggestion that prevalence of mental health conditions are greater in construction workers than the general population. While these results need to be interpreted with caution due to the small amount of literature available and therefore analysed, as well as the result of identified issues with heterogeneity, they do indicate that further research in this area is required. Furthermore, as stated above, the indication that methodological limitations identified in some studies may play a role in the significance of outcomes suggests the need for development of standardised methodologies.

While the increased prevalence and odds of mental health conditions in the construction industry has been supported by the majority of findings, the analysis of articles reporting risk ratios suggests differently. Pooled analysis of these articles suggested no increased risk of mental health conditions for those in the construction industry in comparison to the general working population or a comparison group of white collared workers. Furthermore, when controlling for either non-clinical outcome measures or sample under-representation no increased risks were observed. Despite these outcomes results need to be interpreted with caution. The availability of research using similar study designs is limited and as a result restricts the ability to effectively analyse the data, with restrictions to effectively control for identified methodological issues. Additionally, with suggestion that the construction industry may be affected by adherence to masculine culture men may not be disclosing the presence of mental health conditions. Furthermore, there is literature that suggests that the use of gender specific measures may prove more effective at capturing mental health condition

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presence. Based on the equivocal findings and the small amount of literature, as well as possible disclosure issues as the result of masculine culture adherence, the recommendation is for further investigation in this area to occur before broader conclusions are drawn.

Strengths and Limitations of the Current Study

A significant strength of the current study lies in the developed search strategy which allowed for the assessment of a broad range of literature that may have been relevant to the topic. The incorporation of suicide and related concepts in the search strategy ensured that all relevant articles with suicidal ideation as an outcome. Additionally, using an eligibility criterion that restricted article inclusion to those studies that explicitly stated that samples were employed in the construction industry allows for results to be interpreted with confidence that they are relevant to that industry, independent of others.

At the same time, there are some limitations with the current study that require mention. There was a large amount of heterogeneity in the identified studies, likely the result of vast differences in mental health condition measurement and classification, sample representation and comparison groups, as well as location and time variation between studies. While the statistical analyses undertaken attempted to control for this issue, as a result, findings need to be interpreted with caution. Additionally, while the eligibility criteria allowed for results to be interpreted with confidence in relation to their relevance to the construction industry, this method may have restricted the study's ability to capture construction workers included in broader samples, such as those included in similar blue-collar work environments (e.g., mining). Future research that uses sensitivity analysis to discern if differences between outcomes based on industry classification methods may prove beneficial.

Implications and Future Research

The current study identifies the need for more research in the area of suicidal ideation and mental health conditions for those working in the construction industry. While the search strategy was broad enough to capture relevant literature, the amount suitable for analysis was less than desired. The current study also indicates the importance of standardised methodologies used to confirm the suggestions made in this paper. Future research may additionally consider the use of gender specific measurements to allow for issues related to masculine culture adherence as well as ensuring the appropriate representation of construction workers when sampling. Given the findings showing the slightly increased prevalence and odds of mental health conditions experienced by construction workers, the suggestion by scholars to target suicidal ideation or mental health conditions may allow for effective suicide prevention.

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Appendix A

Medline (PubMed) Search Terms and Keywords

((("Suicide"[mh] OR suicide[tw] OR attempted suicide[tw] OR suicide attempt* OR suicidal behav*[tw] OR parasuicide*[tw] OR suicidal ideation*[tw] OR suicidal thought*[tw] OR "Mental Disorders"[mh] OR, mental disorder*[tw] OR mental disorder diagnos*[tw] OR psychiatric diagnos*[tw] OR psychological diagnos*[tw] OR behaviour disorder*[tw] OR behavior disorder*[tw] OR severe mental disorder*[tw] OR psychological illness[tw] OR psychiatric illness[tw] OR severe psychological illness[tw] OR severe psychiatric illness[tw] OR mental illness[tw] OR severe mental illness[tw] OR "Mental health"[mh] OR mental health [tw] OR Mental Hygiene [tw] OR "mental health services"[mh] OR mental health service*[tw])) AND ("Construction Industry"[mh] OR construction industr*[tw] OR construction trade*[tw] OR building trade*[tw] OR building industr*[tw] OR builder*[tw] OR electrician*[tw] OR plumber*[tw] OR scaffolder*[tw] OR labourer*[tw] OR apprentice*[tw] OR tradesman[tw] OR tradesmen[tw] OR tradespeople[tw] OR tradesperson[tw] OR construction worker*[tw] OR carpenter*[tw] OR labouring[tw])

Embase Search Terms and Keywords

"suicidal behaviour"/exp OR "suicide" OR "suicidal ideation" OR "suicide attempt*" OR "suicidal behav*" OR parasuicide* OR "suicidal thought*" OR "mental disorders"/de OR "mental disorder"/exp OR "mental disorder diagnos*" OR "psychiatric diagnos*" OR "psychological diagnos*" OR "behaviour disorder*" OR "severe mental disorder*" OR "psychological illness" OR "psychiatric illness"/de OR "severe psychological illness" OR "severe psychiatric illness" OR "mental illness"/de OR "severe mental illness"/de OR "mental health"/exp OR "mental health"/de OR "mental care"/de OR "mental condition*" OR "mental factor"/de OR "mental help"/de OR "mental service"/de OR "mental state"/de OR "mental status"/de AND "building industry"/exp OR "building industr*" OR "construction work*" OR "construction trade*" OR "building trade*" OR "construction industr*"

PsychInfo Search Terms and Keywords

exp Mental Disorders/ or mental disorder diagnos*.mp. or psychiatric diagnos*.mp. or psychological diagnos*.mp. or behaviour disorder+.mp. or severe mental disorder+.mp. or psychological illness.mp. or psychiatric illness.mp. or severe psychological illness.mp. or severe psychiatric illness.mp. or mental illness.mp. or severe mental illness.mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] or exp mental health/ or mental care.mp. or mental condition+.mp. or mental factor+.mp. or mental help.mp. or mental service.mp. or mental state.mp. or mental status.mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] or exp Suicide/ or attempted suicide.mp. or suicide attempt+.mp. or suicidal behave+.mp. or parasuicide+.mp. or suicidal ideation+.mp. or suicidal thought+.mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] AND exp blue collar workers/ or construction Industr+ or construction trade+ or building trade+ or building industr+ or builder+ or electrician+ or plumber+ or scaffolder+ or labourer+ or apprentice+ or tradesman or tradesmen or tradespeople or tradesperson or construction worker+ or carpenter+ or labouring

Scopus Search Terms and Keywords

suicidal behaviour} OR suicide OR {suicidal ideation} OR {suicide attempt} OR {suicide attempts}
OR {suicidal behaviour} OR {suicidal behaviour} OR parasuicide* OR {suicidal thought} OR {suicidal
thoughts} OR {mental disorders} OR {mental disorder} OR {mental disorder diagnosis} OR {mental
disorder diagnoses} OR {psychiatric diagnosis} OR {psychiatric diagnoses} OR {psychological
diagnosis} OR {psychological diagnoses} OR {behaviour disorder} OR {behaviour
disorders} OR {severe mental disorder} OR {severe mental disorders} OR {psychological
illness} OR {psychiatric illness} OR {severe psychological illness} OR {severe psychiatric
illness} OR {mental illness} OR {severe mental illness} OR {mental health} OR {mental
care} OR {mental condition} OR {mental conditions} OR {mental factor} OR {mental help} OR {mental
service} OR {mental state} OR {mental status}) AND ((Construction Industry} OR {construction
trade} OR {construction trade} OR {building trade} OR {building trades} OR {building industry} OR
{building industries} OR builder* OR {construction worker} OR {construction workers} OR {blue collar
worker

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Appendix B

Table 1. Article Quality Assessment: Mixed Methods Assessment Tool

Lead Author, Year and Article Reference Number	Title	Outcome	Study Design/Sample	Measure of Effect	Screening Questions		Study Appraisal Questions Dependent on Study Design (Yes, No, Unclear=UNC)					Comments
					S.1	S.2	Q.1	Q.2	Q.3	Q.4	Q.5	
Zheng et al., 2010, 1	Nonfatal unintentional injuries and related factors among male construction workers in Central China	Mental health	Quantitative Descriptive/Males only	Prevalence Rate	YES	YES	YES	YES	YES	YES	YES	Mental health condition categorised based on POMS depression measure
VanDerMolen et al., 2016, 2	Incidence rates of occupational diseases in the Dutch construction sector, 2010-2014	Mental health	Quantitative Descriptive/Males only	Prevalence Rate & Incidence Rate Ratio	YES	YES	YES	YES	NO	YES	YES	Mental health condition categorised based on doctor diagnosis of ICD-10 mental distress/burnout
Theorell et al., 1976, 3	The relationship of disturbing life changes and emotions to the early development of myocardial infarctions and other serious illnesses	Mental health	Quantitative Descriptive/Males only	Prevalence Rate	YES	YES	YES	NO	NO	YES	YES	Mental health condition categorised based on self-reported suicidal ideation or neurosis, psychoneurosis, anxiety, neurotic depression or asthenia episodes causing sick leave >30 days. Sample aged between 41-61 years
Telle-Lamberton et al., 2018, 4	Trends in work-related mental disorders by sector in France	Mental health	Quantitative Non-Randomized/ All persons	Reporting Odds Ratio	YES	YES	YES	YES	YES	YES	UNC	Mental health condition categorised by doctor diagnosis of ICD-10 mental disorders. Adjusted for sex, age, and time period 2001-2011
Stocks et al., 2010, 5	The incidence of medically reported work-related ill health in the UK construction industry	Mental health	Quantitative Descriptive/Men only	Rate Ratio	YES	YES	YES	YES	YES	YES	YES	Doctor diagnosis of mental ill health
Pidd et al., 2017, 6	Young construction workers: substance use, mental health, and workplace psychosocial factors	Mental health	Quantitative Descriptive/Men only	Prevalence	YES	YES	YES	NO	YES	YES	YES	Mental health condition categorised by high (22-29), very high (30+) scores on the K-10 scale. Only assesses apprentices in construction

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Lead Author, Year and Article Reference Number	Title	Outcome	Study Design/Sample	Effect Size or Measure	Screening Questions		Study Appraisal Questions Dependent on Study Design (Yes, No, Unclear)					Comments
					S.1	S.2	Q.1	Q.2	Q.3	Q.4	Q.5	
Petersen et al., 1998, 7	Comparison of health outcomes among older construction and blue-collar employees in the United States	Mental health	Quantitative Non-randomized/ Males only	Odds Ratio	YES	YES	NO	YES	YES	YES	YES	Mental health condition categorised as previous doctor diagnosis of emotional or mental health condition. Only assesses 51 to 61-year-old construction workers. Adjusts for age and employment status (e.g. part time)
Muntaner et al., 1991, 8	Occupational characteristics and the occurrence of psychotic disorders	Mental health	Quantitative Non-randomized/ All persons	Estimated Relative Risk	YES	YES	YES	YES	YES	YES	YES	Mental health condition categorised based on semi-structured interview for DSM-III schizophrenia criterion A. Controlling for socio-demographic, psychopathological, alcohol and marijuana use factors
Jacobsen et al., 2014, 9	Construction workers struggle with a high prevalence of mental distress, and this is associated with their pain and injuries	Mental health	Quantitative Descriptive/ All persons	Prevalence	YES	YES	YES	YES	YES	NO	YES	Mental health condition categorised by HSCL scores above 1.50
Boschman et al., 2014, 10	The impact of common mental disorders on work ability in mentally and physically demanding construction work	Mental health	Quantitative Descriptive/All persons	Prevalence	YES	YES	YES	NO	NO	YES	YES	Mental health condition categorised by self-reported distress and need for recovery. Only assesses bricklayers and their supervisors
Lim et al., 2017, 11	Analysing psychological conditions of fieldworkers in the construction industry	Mental health	Quantitative Descriptive/ All persons	Prevalence	YES	YES	YES	YES	YES	YES	YES	Mental health condition categorised based on CES-D and STAI-T scores.
Eaton et al., 1990, 12	Occupations and the prevalence of major depressive disorder	Mental health	Quantitative Descriptive/ All persons	Odds Ratio	YES	YES	YES	YES	YES	UNC	YES	Mental health condition categorised based on semi-structured interview assessing DSM III major depressive disorder

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Lead Author, Year and Article Reference Number	Title	Outcome	Study Design/Sample	Measure of Effect	Screening Questions		Study Appraisal Questions Dependent on Study Design (Yes, No, Unclear)					Comments
					S.1	S.2	Q.1	Q.2	Q.3	Q.4	Q.5	
					Arndt et al., 2015, 13	Construction work and risk of occupational disability: a ten year follow up of 14,474 male workers	Mental Health	Quantitative Non-randomized/Males only	Rate Ratio	YES	YES	

Note: Screening questions (for all types) S1. Are there clear research questions? S2. Do the collected data allow to address the research questions? Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Unclear' to one or both screening questions. **Qualitative study design** Q1. Is the qualitative approach appropriate to answer the research question? Q2. Are the qualitative data collection methods adequate to address the research question? Q3. Are the findings adequately derived from the data? Q4. Is the interpretation of results sufficiently substantiated by data? Q5. Is there coherence between qualitative data sources, collection, analysis and interpretation? **Quantitative randomized study design** Q1. Is randomization appropriately performed? Q2. Are the groups comparable at baseline? Q3. Are there complete outcome data? Q4. Are outcome assessors blinded to the intervention provided? Q5. Did the participants adhere to the assigned intervention? **Quantitative non-randomized study design** Q1. Are the participants representative of the target population? Q2. Are measurements appropriate regarding both the outcome and intervention (or exposure)? Q3. Are there complete outcome data? Q4. Are the confounders accounted for in the design and analysis? Q5. During the study period, is the intervention administered (or exposure occurred) as intended? **Quantitative descriptive study design** Q1. Is the sampling strategy relevant to address the research question? Q2. Is the sample representative of the target population? Q3. Are the measurements appropriate? Q4. Is the risk of nonresponse bias low? Q5. Is the statistical analysis appropriate to answer the research question? **Mixed methods study design** Q1. Is there an adequate rationale for using a mixed method design to address the research question? Q2. Are the different components of the study effectively integrated to answer the research question? Q3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted? Q4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? Q5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? **ICD** = International Classification of Diseases, **DSM** = Diagnostic and Statistical Manual of Mental Disorders, **POMS** = Profile of Mood States, **CES-D** = Centre for Epidemiologic Studies Depression Scale, **STAI-T** = State-Trait Anxiety Inventory, **HSCL** = Hopkins Symptom Checklist, **K-10** = Kessler-10.

Suicidal Ideation and Mental Health Conditions in the Construction Industry: A Meta-Analysis

Appendix C

Table 2. Mental Health in Construction Industry Prevalence Rate Standardised Data

Article First Author, Reference Number & Outcome	Article Title	Sample Size/ Outcome Numbers	Standardised Event Rate (n=100)	Confidence Intervals (95%)		Logit Event Rate	Standard Error	Variance
				Upper	Lower			
Zheng et al., 2010, 1, POMS depression measure	Nonfatal unintentional injuries and related factors among male construction workers in Central China	100/36	0.36	0.272	0.458	-0.575	0.208	0.043
VanDerMolen et al., 2016, 2, ICD-10 mental distress/burnout	Incidence rates of occupational diseases in the Dutch construction sector, 2010-2014	100000/338	0.003	0.000	0.090	-5.686	1.723	2.967
Theorell et al., 1976, 3, Self-reported mental health condition causing sick leave >30 days	The relationship of disturbing life changes and emotions to the early development of myocardial infarctions and other serious illnesses	6579/32	0.005	0.000	0.074	-5.303	1.418	2.010
Stocks et al., 2010, 5, Doctor diagnosis of mental ill health	The incidence of medically reported work-related ill health in the UK construction industry	9383/828	0.088	0.046	0.162	-2.335	0.353	0.124
Pidd et al., 2017, 6, high (22-29), very high (30+) scores on the K-10 scale	Young construction workers: substance use, mental health, and workplace psychosocial factors	169/24	0.142	0.086	0.225	-1.799	0.286	0.082
Jacobsen et al., 2014, 9, HSCL scores above 1.50	"Construction workers struggle with a high prevalence of mental distress, and this is associated with their pain and injuries":	172/27	0.157	0.098	0.242	-1.681	0.275	0.076
Boschman et al., 2014, 10, self-reported distress and need for recovery.	The impact of common mental disorders on work ability in mentally and physically demanding construction work	419/115	0.274	0.196	0.370	-0.972	0.224	0.050
Lim et al., 2017, 11, CES-D depression scores.	Analysing psychological conditions of fieldworkers in the construction industry	396/88	0.222	0.151	0.314	-1.253	0.241	0.058
Lim et al., 2017, 11, anxiety STAI-T scores.	Analysing psychological conditions of fieldworkers in the construction industry	396/92	0.230	0.158	0.322	-0.128	0.238	0.056
Random effects model			0.175	0.117	0.255	-	-	-

Note: ICD = International Classification of Diseases, DSM = Diagnostic and Statistical Manual of Mental Disorders, POMS = Profile of Mood States, CES-D = Centre for Epidemiologic Studies Depression Scale, STAI-T = State-Trait Anxiety Inventory, HSCL = Hopkins Symptom Checklist, K-10 = Kessler-10.

Appendix D

Funnel Plot of Standard Error by Logit event rate

