



Disentangling Rates, Risk, and Drivers of Suicide in the Construction Industry

A Systematic Review

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Abstract: *Background:* Research suggests construction industry workers (CIWs) face increased suicide vulnerability. *Aims:* The current study synthesizes international evidence examining rates, risk, and drivers of CIW suicide. *Method:* Comprehensive searches of MEDLINE, PsycInfo, Embase, Emcare, Web of Science, Scopus, and gray literature were undertaken, identifying studies that discussed, theorized about, or demonstrated risks and/or rates and/or drivers of CIW suicide, without inclusion of other industries. *Results:* A number of included studies statistically analyzed suicide outcomes in a variety of CIW populations, with the majority reporting increased rate and/or risk, however significant heterogeneity limited comparisons. Twenty-five potential drivers were identified and classified as personal- or industry-related. Disentanglement highlighted the relevance of previously understood personal drivers, need for future focus on industry drivers, and potential interplay between drivers. *Limitations:* Exclusion of non-English articles as well as inability to extend analysis to fully understand rates and/or risk of CIW suicide and tenuous links between suggested drivers and suicide outcomes. *Conclusion:* Despite limitations, this paper aids understanding in relation to the suggestion that CIWs are at increased suicide vulnerability. Disentanglement of potential drivers demonstrates the importance of future research focused on industry drivers to assist in prevention strategies.

Keywords: construction industry, suicide, systematic review, suicide prevention

Suicide is a global public health concern with outcomes shown to be disproportionately high within certain populations (World Health Organization, 2020). Research suggests one such vulnerable population is construction industry workers (CIWs; World Health Organization, 2020). An Australian study of male Queensland CIWs revealed statistically higher standardized mortality ratios (SMR) when compared to the Australian male population [SMR (95% CI) = 1.46 (1.13–1.85); Heller et al., 2007]. Additionally, a meta-analytic review demonstrated common CIW occupations such as laborers (RR = 1.84, 95% CI = 1.46–2.33) and skilled tradesman (RR = 1.1, 95% CI = 1.0–1.3) experienced increased suicide risk when compared with broader working-age populations (Milner et al., 2013).

Research in this field is accumulating, and some researchers have theoretically suggested, discussed, or demonstrated potential drivers. Drivers of suicide are

defined as contributing factors, central in an individual's suicidal state development and experience, and may be demographic, psychological, or situational/environmental in nature (Ellis et al., 2015). Some drivers may also be defined as personal in nature (e.g., age) and, therefore, not unique to the population in focus and better served by broader social change (Ellis et al., 2015; O'Connor & Kirtley, 2018). Alternatively, others may be defined as population-specific (situational/environmental in nature, e.g., working conditions and culture) and amendable through industry change (Ellis et al., 2015; O'Connor & Kirtley, 2018). Fundamentally, knowledge of population-relevant drivers is important in mitigating suicide trajectories.

While the research base supports the hypothesis of CIW vulnerability to suicide, a significant limitation has been acknowledged by authors in the area regarding incorporation of other industries in analyzed samples of CIWs,

likely leading to distortion and limiting true contextual understanding of CIW suicide (Milner et al., 2013). Similarly, a recent literature review that describes CIW suicide risk factors falls into this category (Tijani et al., 2021). Therefore, the purpose of this paper was to review rates/risk of suicide outcomes for CIWs and to highlight and disentangle potential drivers while limiting information synthesis to studies focused on CIW alone. This approach builds on previous work in the area, contextually informing future research and preventative approaches.

Method

Search Strategy

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and registered with PROSPERO (Identification Number: CRD42020136365; Moher et al., 2009). The search strategy (detailed in table in Electronic Supplementary Material 2 [ESM 2]) included searches of the MEDLINE, PsycInfo, Embase, Emcare, Web of Science, and Scopus databases. Additionally, gray literature was searched, and included (single study), because regular reports in this area are based on methodologically sound studies and prepared by highly regarded scholars. Hand searches of primary search results references lists were conducted. ST conducted initial database and gray literature searches and duplicate removal. Title and abstract screening, full-text reviews, and reference list checks were completed by ST and KP, with mismatched study classifications resolved by consensus or moderation.

Eligibility Criteria and Selection of Studies

Empirical studies that analyzed data and consequently discussed, theorized/theoretically suggested (relevance based on theory rather than study data), or demonstrated risks and/or rates and/or drivers of CIW suicide were included. Findings from any time and all study designs, excluding case studies, were eligible. Nonempirical or non-English records were excluded, as were those not clearly defining investigated population as employed in the construction industry or incorporated other populations within sample.

Quality Assessment

Studies were independently assessed using the Mixed Methods Appraisal Tool, with ST reviewing all studies and

KP cross-checking 40% (randomly selected) of studies for inter-rater reliability, with 100% concordance (the results shown in table in ESM 3; Hong et al., 2018).

Data Extraction and Analysis

Information extracted from studies included title, authors, location, study time, description of study population, and comparison population (if present), as well as suicide drivers discussed, theorized/theoretically suggested, or demonstrated. Data extraction was undertaken by ST, with KP independently cross-checking 40% (randomly selected) of studies for inter-rater reliability, with 100% concordance.

Results

Study Selection

Search strategies identified a total of 778 records as at 15th of February 2021. As detailed in Figure 1, after duplicate removal, 389 records were left for title and abstract screening, leading to exclusion of a further 302 records. Eighty-seven records were full-text screened, as well as eight additional studies from gray literature and hand searching of reference lists. Following exclusion, 16 studies were included in synthesis.

Included Study Overview

Studies were published from 1994 to 2020 and came primarily from the United States (Hawkins et al., 2020; Kposowa, 1999; Liu & Waterbor, 1994; Robinson et al., 1999; Stern & Haring-Sweeney, 1997; Van-Wijngaarden, 2003; Welton et al., 2020) and Australia (Andersen et al., 2010; Heller et al., 2007; Maheen et al., 2020; Milner et al., 2014; Milner et al., 2017). Single studies came from the United Kingdom (Windsor-Shellard & Gunnell, 2019), Italy (Alicandro et al., 2020), Sweden (Järholm & Stenberg, 2002), and Finland (Notkola et al., 1993).

Study designs were primarily quantitative (Alicandro et al., 2020; Andersen et al., 2010; Hawkins et al., 2020; Järholm & Stenberg, 2002; Kposowa, 1999; Liu & Waterbor, 1994; Maheen et al., 2020; Notkola et al., 1993; Stern & Haring-Sweeney, 1997; Van-Wijngaarden, 2003; Welton et al., 2020; Windsor-Shellard & Gunnell, 2019). One employed qualitative methods (Milner et al., 2017), and another mixed methods (Heller et al., 2007). Samples varied greatly. Some were restricted by gender (e.g., some only included men due to low numbers of

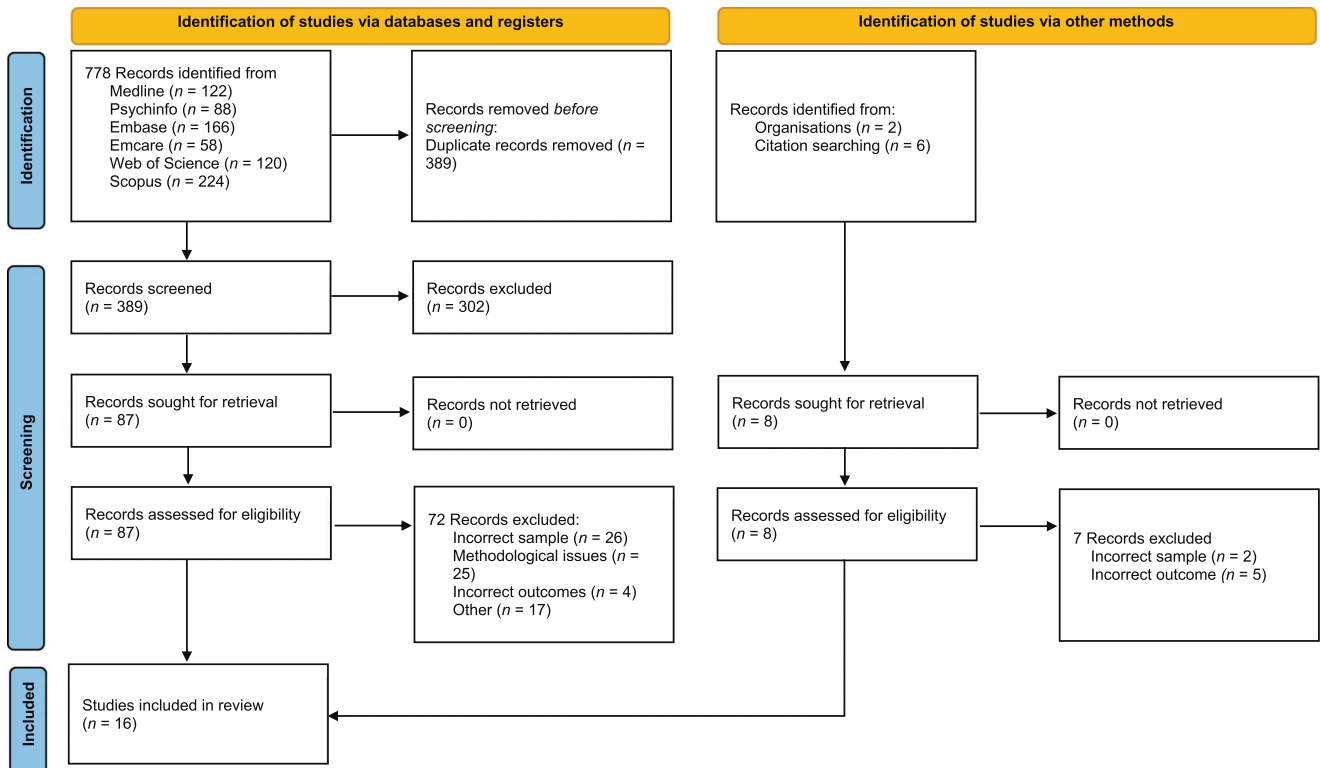


Figure 1. Prisma flowchart for study selection.

women in samples), age, and job roles (e.g., only included specified roles within construction industry, e.g., construction electricians). Comparison populations also differed. Some studies made comparisons to the general population, those representatives of the area's population, employed individuals, and those of matched work environment or alternative professions.

Suicide Rates and Risk

Fifteen of the 16 studies reported statistics on CIW suicide outcomes. It was difficult to make direct comparisons between studies due to the differences in samples and comparison groups (mentioned above), as well as differences in statistical methods. Despite this, 13 studies demonstrated statistically significant higher rates or risk of suicide for CIWs in juxtaposition to one or both of their comparison groups (Alicandro et al., 2020; Andersen et al., 2010; Hawkins et al., 2020; Heller et al., 2007; Järholm & Stenberg, 2002; Kposowa, 1999; Liu & Waterbor, 1994; Maheen et al., 2020; Milner et al., 2014; Notkola et al., 1993; Robinson et al., 1999; Stern & Haring-Sweeney, 1997; Van-Wijngaarden, 2003; Welton et al., 2020; Windsor-Shellard & Gunnell, 2019).

Potential Drivers of CIW Suicide

Potential drivers of CIW suicide are collated and outlined below (overview provided in table in ESM 1). Studies theorized/theoretically suggested (relevance based on theory rather than study data) and/or discussed and/or demonstrated, through qualitative methods and/or through inclusion as covariates in statistical models, potential drivers of CIW suicide.

Covariates were often personal in nature (e.g., age), previously understood as drivers of suicide and unlikely to be influenced by industry or intervention groups. Alternatively, most drivers theorized/theoretically suggested as relevant, or identified based on qualitative evidence, were related to industry/environment, population-specific, and potentially open to influence.

For clearer disentanglement and to outline areas of focus for future endeavors, potential drivers of CIW suicide are thematically grouped into personal or industry drivers (Figure 2).

Personal-Related Drivers

Socioeconomic/Demographic Factors

Sixteen studies highlighted the role socioeconomic/demographic factors may play as drivers of CIW suicide.

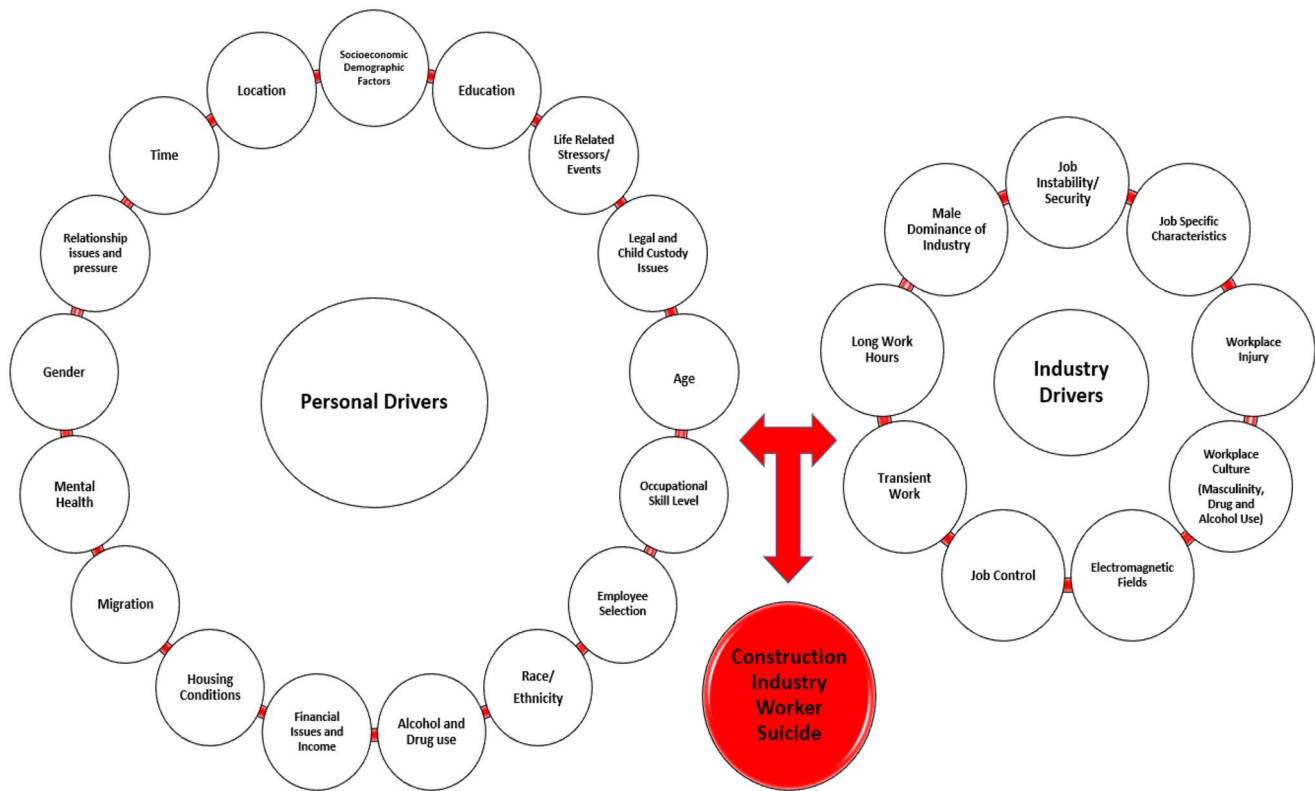


Figure 2. Drivers of construction industry worker suicide and their complex interaction.

Some studies theorized relevance (Alicandro et al., 2020; Andersen et al., 2010; Hawkins et al., 2020; Järholm & Stenberg, 2002; Kposowa, 1999; Liu & Waterbor, 1994; Milner et al., 2014; Welton et al., 2020; Windsor-Shellard & Gunnell, 2019). One identified relevance through qualitative analysis (Milner et al., 2017), and others through inclusion as covariates in quantitative analysis (Alicandro et al., 2020; Andersen et al., 2010; Hawkins et al., 2020; Heller et al., 2007; Järholm & Stenberg, 2002; Kposowa, 1999; Liu & Waterbor, 1994; Maheen et al., 2020; Milner et al., 2014; Notkola et al., 1993; Robinson et al., 1999; Stern & Haring-Sweeney, 1997; Van-Wijngaarden, 2003; Welton et al., 2020; Windsor-Shellard & Gunnell, 2019). Some studies delineated socioeconomic/demographic drivers, and these are outlined below.

Age

Age was included as a covariate in 10 analyses, adjusting for differences in suicide risk across one's lifespan (Alicandro et al., 2020; Hawkins et al., 2020; Järholm & Stenberg, 2002; Kposowa, 1999; Maheen et al., 2020; Notkola et al., 1993; Stern & Haring-Sweeney, 1997; Van-Wijngaarden, 2003; Welton et al., 2020; Windsor-Shellard & Gunnell, 2019). Age was generally treated as a confounder to be adjusted for, not investigated in itself as a predictor of

suicide outcome. One study theorized age as a driver due to the likelihood of increased exposure to low occupational skills and bullying for younger CIWs (Milner et al., 2014).

Gender/Sex

Eleven studies considered only males due to the limited number of women sampled and suicide outcome gender disparities (Alicandro et al., 2020; Andersen et al., 2010; Heller et al., 2007; Järholm & Stenberg, 2002; Maheen et al., 2020; Milner et al., 2014; Milner et al., 2017; Notkola et al., 1993; Stern & Haring-Sweeney, 1997; Welton et al., 2020; Windsor-Shellard & Gunnell, 2019). Gender/sex was included as a covariate in three analyses, but like age, it was generally treated as a confounder rather than a predictor of interest (Hawkins et al., 2020; Kposowa, 1999; Van-Wijngaarden, 2003). One study that did examine the effect of adding gender/sex as a covariate (along with other covariates) found a large decrease in risk (Kposowa, 1999). However, interpreting this result is difficult as it is unclear which individual covariates influenced this change or how the covariate was coded.

Region of Residence

Five studies included regions of residence (ROR; primarily operationalized as state/county, e.g., Queensland, Australia) as a covariate in analyses based on the suggestion that some

ROR are associated with increased suicide outcomes (Alicandro et al., 2020; Kposowa, 1999; Liu & Waterbor, 1994; Notkola et al., 1993; Van-Wijngaarden, 2003). Three of these studies did not provide information on how adjusting for ROR influenced results. One study indicated minimal changes in suicide risk when county of residence was included in analysis (Liu & Waterbor, 1994). The remaining study reported large changes in risk when residence in Western and Mountain States of the United States was included in analysis, alongside other covariates, suggesting ROR as potentially relevant in CIW suicide outcomes, particularly for this study population (Kposowa, 1999).

Education

Five studies included level of education as a covariate (Alicandro et al., 2020; Hawkins et al., 2020; Kposowa, 1999; Notkola et al., 1993; Van-Wijngaarden, 2003). Two studies did not report on how adjusting for education affected results. However, the remaining three studies all demonstrated differences in suicide risk estimates when including education in analysis either singularly (Alicandro et al., 2020) or alongside other covariates (Kposowa, 1999; Notkola et al., 1993). While these studies provided minimal information regarding the role education played, differences were observed: Three suggested lower levels of educational attainment increased suicide risk (Alicandro et al., 2020; Hawkins et al., 2020; Notkola et al., 1993), while the other indicated higher levels of increased suicide risk (Van-Wijngaarden, 2003).

Mental Health

Three studies theorized the presence of mental health conditions may drive CIW suicide due to potential issues with help-seeking and offering for mental health challenges suggested as apparent within the construction industry (Hawkins et al., 2020; Milner et al., 2014; Milner et al., 2017). Additionally, one study qualitatively demonstrated mental health's relevance as a driver, with presence in over 50% of retrospectively analyzed CIW suicides (Milner et al., 2017).

Race/Ethnicity

Three studies included race/ethnicity as a covariate due to the suggestion that certain populations are at greater risk of suicidal outcome than others (operationalized dependent on the study location to reflect areas' predominant race/ethnicities; Hawkins et al., 2020; Kposowa, 1999; Van-Wijngaarden, 2003). Two of these studies did not examine the effect of adjusting for race/ethnicity on suicide risk estimates. One study demonstrated a large change in risk when race/ethnicity was included in modeling with other covariates, suggesting identification of Hispanic, African/American as potentially relevant in CIW suicide, particularly for this study population (Kposowa, 1999).

Migration

One study, focused on CIWs who immigrated to the United States from Mexico, theorized migration as a CIW suicide driver proposing migration challenges, coupled with stressful and high-risk work environments, may increase suicide risk (Welton et al., 2020).

Housing Conditions

One study included housing conditions as a covariate in analysis. No information is offered on operationalization, but significant change in statistical outcome was observed when included in modeling with other covariates, indicating the potential relevance of housing conditions in CIW suicide (Notkola et al., 1993).

Significant Life Event

One study theorized significant life events may influence one's trajectory toward suicidal behaviors (Milner et al., 2014). What constitutes a significant life event was not discussed, but it would be assumed instances such as a relative/friend passing or job loss are events that would fit this category.

Financial Issues and Income

One study included income as a covariate in analyses, and a large change in suicide risk was seen when included in modeling with other covariates, suggesting financial situation plays a role in CIW suicide (Kposowa, 1999). Five studies theorized the role of finances/income as a potential driver, outlining decreased income may impact psychological well-being, subsequently increasing suicide risk (Alicandro et al., 2020; Heller et al., 2007; Kposowa, 1999; Milner et al., 2017; Windsor-Shellard & Gunnell, 2019). Another study theorized that the role of finances/income may be situationally dependent, with industry stability issues likely influencing this driver (Alicandro et al., 2020). Two studies found qualitative support for the role of finances/income as a driver, with financial challenges suggested to increase CIW suicide risk (Heller et al., 2007; Milner et al., 2017).

Relationship Status, Issues, and Pressure: Spousal and Collegial

Marital/relationship status was included as a covariate in three studies with the suggestion that being single, divorced, or widowed increases CIW suicide risk (Kposowa, 1999; Notkola et al., 1993; Van-Wijngaarden, 2003). One of these studies did not report on how adjusting for marital/relationship status affected estimates of suicide risk. Another study reported small or negligible effects of adjusting for marital status (Notkola et al., 1993). The final study reported a large decrease in suicide risk when marital/relationship status was included in modeling with other covariates (Kposowa, 1999). Five studies theoretically suggested the role of relationship issues/breakdown

as a driver (Andersen et al., 2010; Heller et al., 2007; Milner et al., 2014; Milner et al., 2017; Windsor-Shellard & Gunnell, 2019), with two studies demonstrating relevance, using qualitative methods (Heller et al., 2007; Milner et al., 2017). One study discussed that these relationship issues are not confined to spousal relationships but may also occur within the workplace (Heller et al., 2007).

Legal and Child Custody Issues

One study used qualitative analysis to demonstrate legal and/or child custody issues as a driver, including inability to negotiate access and workplace or postdivorce matters, with this issue identified in four of the 34 analyzed suicides of CIWs (Milner et al., 2017).

Alcohol and Other Drug Use

Five studies theorized alcohol and substance use as a driver of CIW suicide (Andersen et al., 2010; Heller et al., 2007; Milner et al., 2014; Milner et al., 2017; Windsor-Shellard & Gunnell, 2019). Heller et al. (2007) suggested that alcohol and substance misuse may be used as a coping strategy, normalized by industry culture, and two studies indicated, through qualitative analysis, the presence of alcohol and drugs in analyzed suicide deaths (Heller et al., 2007; Milner et al., 2017).

Occupational Skill Level

Two studies stratified analyses by occupational skill level (e.g., qualified tradesman vs. laborer), with both demonstrating through statistical comparisons lower occupational skill levels may drive CIW suicide (Milner et al., 2014; Notkola et al., 1993). Milner et al. (2014) theorized that this may be driven by younger male workers, those of lower socioeconomic status, and decreased psychosocial work factors being over-represented in this high-risk cohort.

Employee Selection

Three studies theorized CIW suicide may be in part driven by differential employee selection (Järholm & Stenberg, 2002; Kposowa, 1999; Liu & Waterbor, 1994). While deeper discussion of this potential driver is limited within studies, it is suggested that individuals with personality types or lifestyles that increase suicide risk (e.g., lower socioeconomic status or increased risk-taking behaviors) may be more likely to be employed in the construction industry, creating rate disparity.

Industry Drivers

Job-Specific Characteristics

Eleven studies theorized job-specific characteristics as a CIW suicide driver (Alicandro et al., 2020; Andersen et al., 2010; Hawkins et al., 2020; Heller et al., 2007; Järholm & Stenberg, 2002; Kposowa, 1999; Liu & Waterbor, 1994;

Maheen et al., 2020; Milner et al., 2014; Milner et al., 2017; Windsor-Shellard & Gunnell, 2019). Some studies did not delineate further than stating the potential role of job-specific characteristics; however, those that did are detailed below.

Job Instability/Security

Job instability/security was theoretically suggested by seven studies based on the negative role decreased job security can have on one's mental health (Alicandro et al., 2020; Heller et al., 2007; Liu & Waterbor, 1994; Maheen et al., 2020; Milner et al., 2014; Milner et al., 2017; Windsor-Shellard & Gunnell, 2019). While many studies simply mentioned its potential relevance, others explicitly discussed how risk of being unemployed may impact self-value perceptions, subsequently driving CIW suicide (Heller et al., 2007; Maheen et al., 2020). Two studies used qualitative methods to demonstrate relevance (Heller et al., 2007; Milner et al., 2017).

Job Control

Two studies theorized low levels of job control as a driver (Maheen et al., 2020; Milner et al., 2014). While Maheen et al. (2020) simply referred to the role decreased job control may play, Milner et al. (2014) theorized that certain cohorts within the construction industry (e.g., lower skilled CIWs) may be at increased risk due to lower levels of organizational and work structure control, impacting psychological well-being and subsequently increasing the risk of suicidal behaviors.

Transient Work

One study used qualitative methods to demonstrate transient work experiences as a driver, with increases in transience and instability observed in 10 of the 34 CIW cases analyzed following death by suicide (Milner et al., 2017). Importantly, the study notes age differences within this potential driver, discussing the fact that younger workers may have difficulties transitioning from school, while older workers may experience issues adjusting to new working environments, resulting from the transient nature of the construction industry.

Long Work Hours

Three studies theoretically suggested the role of long work hours on CIW suicide (Andersen et al., 2010; Heller et al., 2007; Maheen et al., 2020). Two of the studies only briefly referenced this potential driver in relation to previous work; however, Heller et al. (2007) demonstrated its relevance through qualitative methods, detailing how long working hours impact family and recreational activities time, subsequently decreasing psychological well-being, and increasing suicide risk.

Male Dominance of Industry

Six studies theoretically suggested male dominance of the construction industry as a CIW suicide driver (Andersen et al.,

2010; Heller et al., 2007; Liu & Waterbor, 1994; Maheen et al., 2020; Milner et al., 2014; Welton et al., 2020). With suicide rates generally greater for men than women, all studies concurred that increased suicide rates in male-dominated industries are expected; however, all suggested gender disparity is unlikely to fully explain increased outcomes.

Workplace Injury

Workplace injury experiences were identified in one study (Milner et al., 2017). This qualitative study identified workplace injuries occurring among several middle-aged and older workers, alluding to the role injury outcomes such as severe pain, disability, financial or mental health challenges, and reinjury, play in increasing distress and suicide risk.

Workplace Culture: Masculinity, Help-Seeking Behavior, and Bullying

Four studies theorized workplace culture and subsequent behaviors as potential CIW suicide drivers (Andersen et al., 2010; Heller et al., 2007; Milner et al., 2014; Milner et al., 2017). Two studies only broadly mentioned workplace culture's potential role (Andersen et al., 2010; Milner et al., 2014). One study demonstrated through qualitative methods the role of bullying culture as a potential driver (Heller et al., 2007). Masculine workplace culture was also highlighted, with one study theorizing the industry may employ, and/or encourage, individuals to adhere to traditional gender norms (e.g., restricted emotionality), increasing stigma against suicide or mental health problems, negatively impacting help-seeking/offering behaviors, and therefore increasing suicide risk (Milner et al., 2017).

Electromagnetic Fields

One study theorized electromagnetic field (EMF) exposure, which may inhibit production of melatonin, increasing depression and subsequently suicide risk, as a potential driver, with some CIW populations regularly exposed to EMFs (Järholm & Stenberg, 2002).

Discussion

This study brings together international evidence from studies using differing methodologies to examine potential rates and risk of CIW suicide, as well as categorizing and disentangling potential drivers. This study addresses a gap in the literature by synthesizing the research stream allowing for an updated, targeted, and contextual understanding of CIW suicide, to inform decision makers, preventative groups, and future research.

Rates and Risk of Construction Industry Worker Suicide

The majority of included studies statistically analyzed suicide outcome rates and risk in various CIW populations. Most studies reported statistically higher suicide outcomes for CIWs when juxtaposed to comparison populations. Therefore, an increased rate and/or risk of suicide for CIWs is suggested; however, further research is needed. The authors acknowledge a significant limitation in making comprehensive comparisons across studies due to significant heterogeneity in samples and comparison populations. This limitation has been identified previously within the seminal work of Milner et al. (2018), acknowledging occupation/industry classification methods are likely to have resulted in the inclusion of individuals employed outside of the industry (e.g., mining, manufacturing) in analyzed samples (categorized as representative of the CIW alone), therefore diluting contextual understanding. While the methodology of the current work attempts to rectify this limitation, the results highlight the need for future research to address this issue more directly. The use of more standardized methodologies (e.g., CIW samples wholly representative of the industry, general, or matched comparison populations) allowing for robust comparisons is recommended.

Drivers of Construction Industry Worker Suicide

The present review identified 25 potential drivers of CIW suicide. Differing methods of support can be seen between studies; however, these come primarily in the form of theoretical suggestions (not supported by study data), particularly regarding areas open to mitigation. This is concerning, as while such drivers may prove relevant, their link remains tenuous until further supported by empirical evidence. Similarly, some drivers are reported with limited evidence, for example, age, which received only clear support of a theoretical nature from a single study. Despite the negligibility of some links, all suggested drivers were retained (1) to guide future research to be aware of possible need to adjust for these drivers in analysis, with many less supported drivers remaining potentially relevant given the developing nature of the research area; (2) potential for studies outside of the scope of this review demonstrating support to driver relevance; and (3) to demonstrate the likely complex and multifactorial nature of what precipitates CIW suicide. Further research is needed to explicate tenuous drivers to fully understand their nature and scope in CIW suicide outcomes and ecological study methodologies may be useful.

Personal Drivers

Several personal drivers were identified as relevant to CIW suicide, primarily through inclusion as covariates in statistical analyses. Adjusting for some of these drivers (e.g., education, marital status) in statistical models resulted in nontrivial changes to estimates of suicide risk underlining their probable importance. While the ability to fully evaluate personal driver relevance is limited due to low numbers of studies and methodological differences making comparison inappropriate, the findings demonstrate the importance of incorporating personal drivers in future research. Many of these highlighted drivers have been shown as relevant in other populations and therefore likely play a role in CIW suicide. Despite this, few studies considered these drivers beyond adjusting for them as confounders, therefore providing little information on overall relevance (Milner et al., 2013). While understandable, future research would be well served by investigating these drivers more closely and directly reporting on how each affects risk estimates. For example, much commentary has been made on the role of age (younger-aged cohorts more likely to be exposed to bullying behaviors) in CIW suicide (Ross et al., 2021).

Industry Drivers

While understanding of personal drivers is important and requires future research, increased understanding of industry drivers is paramount. Many suggested personal drivers stem from socioeconomic or demographic factors, external to the industry and more effectively influenced by implementing change at a social policy level. Conversely, potential industry drivers identified in this research, such as negative workplace cultures, are likely modifiable through industry focus and prevention groups. However, despite some of these suggested drivers, such as job-specific characteristics (e.g., job control, job design), previously being shown as relevant in other populations, suicide outcomes, minimal research has focused on their relevance in the context of CIWs, with much of the support for the role of these drivers purely theoretical (LaMontagne et al., 2014; Milner et al., 2018). Future research focusing on generating a deeper understanding of the nature, role, and relevance of these industry drivers on CIW suicide outcomes and behavior, to inform industry and prevention groups, is vital.

Driver Interplay

The synthesis highlights the likelihood of a complicated interplay between drivers that may have not been previously acknowledged. For example, factors such as long work hours and transient work conditions likely influence non-work relationships. Conversely, pre-existing mental health

conditions may be heightened due to workplace cultures impacting help-seeking behaviors. While the synthesis highlights the range of potential drivers and need for further investigation into driver relevance by investigating drivers in a delineated format, future research must also be conducted to understand driver interaction. For example, while delineation of drivers is supported by the Integrated Motivational-Volitional model of suicidal behavior, particularly the premotivational phase that differentiates drivers into diathesis-environment-life categories to better understand each driver's role in suicidal behavior, the model also highlights the importance of acknowledging the potential interplay between drivers (O'Connor & Kirtley, 2018). While focus should remain on drivers receiving high empirical support regarding relevance, both researchers and preventive programs would be well served in understanding that drivers cannot always be viewed or addressed independently.

Overlap Between Drivers of Suicide and Opioid Overdose in CIWs

The authors note recent research findings indicating increased opioid-related deaths (ORD) for CIWs in comparison to other working populations, as well as opioid presence postmortem in a large proportion of CIWs who died by suicide (Henn et al., 2022; Shaw et al., 2020). This research suggests similarities between drivers of suicide and ORD/opioid use (e.g., workplace injury, workplace culture). Additionally, this research delineates drivers into similar categories proposed in the current paper, adding support to current papers' suggestion that understanding industry drivers is vital in mitigating suicide outcomes and addressing these may similarly impact ORD/opioid use (Dong et al., 2022; Henn et al., 2022; Shaw et al., 2020).

Limitations

Limitations include exclusion of non-English articles, as well as inability to extend analysis to fully understand rates and/or risk of CIW suicide and tenuous links between suggested drivers and suicide outcomes.

Conclusion

Despite these limitations the current research provides a deeper and more contextual understanding of CIW suicide. The results highlight the need for future research to utilize standardized methodologies, allowing for robust

comparisons and the need to account for commonly understood drivers in future analysis to further understand their relevance. Additionally, the need for future research that concentrates on industry drivers is paramount with current research regularly providing only theoretical support for these potential drivers. Research focusing on the role and relevance of these mitigatable drivers and the potential interplay between drivers is required. Undertaking this research will inform industry change requirements and preventative programs designed to mitigate CIW suicide trajectories.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at <https://doi.org/10.1027/0227-5910/a000885>

ESM 1. Included Article Overview and Description

ESM 2. Search strategy

ESM 3. Quality assessment

References

- Alicandro, G., Bertuccio, P., Sebastiani, G., La Vecchia, C., & Frova, L. (2020). Mortality among Italian male workers in the construction industry: a census-based cohort study. *European Journal of Public Health, 30*(2), 247–252. <https://doi.org/10.1093/eurpub/ckz129>
- Andersen, K., Hawgood, J., Klieve, H., Kölves, K., & De Leo, D. (2010). Suicide in selected occupations in Queensland: Evidence from the state suicide register. *Australian and New Zealand Journal of Psychiatry, 44*(3), 243–249. <https://doi.org/10.3109/00048670903487142>
- Dong, X., Brooks, R. D., Rodman, C., Rinehart, R., & Brown, S. (2022). Pain and prescription opioid use among US construction workers: Findings from the 2011–2018 Medical Expenditure Panel Survey. *American Journal of Public Health, 112*, S77–S87. <https://doi.org/10.2105/AJPH.2021.306510>
- Ellis, T., Rufino, K. A., Allen, J. G., Fowler, J., & Jobes, D. A. (2015). Impact of a suicide-specific intervention within inpatient psychiatric care: The collaborative assessment and management of suicidality. *Suicide & Life-Threatening Behavior, 45*(5), 556–566. <https://doi.org/10.1111/sltb.12151>
- Hawkins, D., Davis, L., Punnett, L., & Kriebel, D. (2020). Disparities in the deaths of despair by occupation, Massachusetts, 2000 to 2015. *Journal of Occupational and Environmental Medicine, 62*(7), 484–492. <https://doi.org/10.1097/JOM.0000000000001870>
- Heller, T., Hawgood, J., & De Leo, D. (2007). Correlates of suicide in building industry workers. *Archives of Suicide Research, 11*(1), 105–117. <https://doi.org/10.1080/1381110600992977>
- Henn, M., Barber, C., Zhang, W., Staley, M., Azrael, D., & Miller, M. (2022). Identifying occupation groups for suicide prevention: A statewide data linkage study. *Archives of Suicide Research, 11*(1), 105–117. <https://doi.org/10.1080/13811118.2021.2020699>
- Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M. P., Griffiths, F., Nicolau, B., O’Cathain, A., Rousseau, M. C., Vedel, I., & Pluye, P. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information, 34*(4), 285–291. <https://doi.org/10.3233/EFI-180221>
- Järholm, B., & Stenberg, A. (2002). Suicide mortality among electricians in the Swedish construction industry. *Occupational and Environmental Medicine, 59*(3), 199–200. <https://doi.org/10.1136/oem.59.3.199>
- Kposowa, A. (1999). Suicide mortality in the United States: Differentials by industrial and occupational groups. *American Journal of Industrial Medicine, 36*(6), 645–652. [https://doi.org/10.1002/\(SICI\)1097-0274\(199912\)36:6<645::AID-AJIM7>3.0.CO;2-T](https://doi.org/10.1002/(SICI)1097-0274(199912)36:6<645::AID-AJIM7>3.0.CO;2-T)
- LaMontagne, A., Martin, A., & Page, K. M. (2014). Workplace mental health: Developing an integrated intervention approach. *BMC Psychiatry, 14*(1), Article 131. <https://doi.org/10.1186/1471-244X-14-131>
- Liu, T., & Waterbor, J. W. (1994). Comparison of suicide rates among industrial groups. *American Journal of Industrial Medicine, 25*(2), 197–203. <https://doi.org/10.1002/ajim.4700250206>
- Maheen, H., LaMontagne, A., & King, T. (2020). *Suicide in the Construction Industry: 2001-2018*. Centre for Health Equity, School of Population and Global Health, University of Melbourne and Institute for Health Transformation, Deakin University. <https://mates.org.au/media/documents/MATES-Report-2020-Suicide-in-the-Construction-Industry-2001-2018-Vol-IV-July-2020.pdf>
- Milner, A., Maheen, H., Currier, D., & LaMontagne, A. (2017). Male suicide among construction workers in Australia: A qualitative analysis of the major stressors precipitating death. *BMC Public Health, 17*(1), 584. <https://doi.org/10.1186/s12889-017-4500-8>
- Milner, A., Niven, H., & LaMontagne, A. (2014). Suicide by occupational skill level in the Australian construction industry: Data from 2001 to 2010. *Australian and New Zealand Journal of Public Health, 38*(3), 281–285. <https://doi.org/10.1111/1753-6405.12205>
- Milner, A., Spittal, M., J., Pirkis, J., & LaMontagne, A. (2013). Suicide by occupation: Systematic review and meta-analysis. *British Journal of Psychiatry, 203*(6), 409–416. <https://doi.org/10.1192/bjp.bp.113.128405>
- Milner, A., Witt, K., LaMontagne, A., & Niedhammer, I. (2018). Psychosocial job stressors and suicidality: a meta-analysis and systematic review. *Occupational and Environmental Medicine, 75*(4), Article b2535. <https://doi.org/10.1136/oemed-2017-104531>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *British Medical Journal, 339*, Article b2535. <https://doi.org/10.1136/bmj.b2535>
- Notkola, V., Martikainen, P., & Leino, P. (1993). Time trends in mortality in forestry and construction workers in Finland 1970–85 and impact of adjustment for socioeconomic variables. *Journal of Epidemiology and Community Health, 47*(3), 186–191. <https://doi.org/10.1136/jech.47.3.186>
- O’Connor, R. C., & Kirtley, O. J. (2018). The integrated motivational-volitional model of suicidal behaviour. *Philosophical Transactions B, 373*(1754), 20170268. <https://doi.org/10.1098/rstb.2017.0268>
- Robinson, C. F., Petersen, M., & Palu, S. (1999). Mortality patterns among electrical workers employed in the U.S. construction industry, 1982–1987. *American Journal of Industrial Medicine, 36*(6), 630–637. [https://doi.org/10.1002/\(sici\)1097-0274\(199912\)36:6<630::aid-ajim5>3.0.co;2-6](https://doi.org/10.1002/(sici)1097-0274(199912)36:6<630::aid-ajim5>3.0.co;2-6)
- Ross, V., Mathieu, S. L., Wardhani, R., Gullestrup, J., & Kölves, K. (2021). Factors associated with workplace bullying and the mental health of construction industry apprentices: A mixed methods study. *Frontiers in Psychiatry, 12*, Article 629262. <https://doi.org/10.3389/fpsy.2021.629262>

- Shaw, W. S., Roelofs, C., & Punnett, L. (2020). Work environment factors and prevention of opioid-related deaths. *American Journal of Public Health, 110*(8), 1235–1241. <https://doi.org/10.2105/AJPH.2020.305716>
- Stern, F., & Haring-Sweeney, M. (1997). Proportionate mortality among unionized construction operating engineers. *American Journal of Industrial Medicine, 32*(1), 51–65. [https://doi.org/10.1002/\(SICI\)1097-0274\(199707\)32:1<51::AID-AJIM7>3.0.CO;2-U](https://doi.org/10.1002/(SICI)1097-0274(199707)32:1<51::AID-AJIM7>3.0.CO;2-U)
- Tijani, B., Falan, J., Jin, X., & Osei-Kyei, R. (2021). Suicide in the construction industry: Literature review. *International Journal of Construction Management. https://doi.org/10.1080/15623599.2021.2005897*
- Van-Wijngaarden, E. (2003). An exploratory investigation of Suicide and occupational exposure. *Journal of Occupational and Environmental Medicine, 45*(1), 96–101. <https://doi.org/10.1097/00043764-200301000-00018>
- Welton, M., Shen, Y., Ebell, M., DeJoy, D., & Robb, S. W. (2020). Construction employment mortality among Mexican immigrants in the South Eastern United States, 2003–2013. *International Journal of Migration, Health and Social Care, 16*(4), 349–358. <https://doi.org/10.1108/IJMHS-08-2018-0055>
- Windsor-Shellard, B., & Gunnell, D. (2019). Occupation-specific suicide risk in England: 2011–2015. *British Journal of Psychiatry, 215*(4), 594–599. <https://doi.org/10.1192/bjp.2019.69>
- World Health Organization (2020). *Suicide worldwide in 2019: Global health estimates*. <https://www.who.int/publications/i/item/9789240026643>





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