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**Estimating the Economic Burden Posed by Work-related Violence to Society: A
Systematic Review of Cost-of-Illness Studies**

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Abstract

Estimates of the economic burden on society posed by work-related violence are important and often highly cited sources of evidence; typically used to substantiate arguments for prevention. However, such sources of information are generally poorly understood and seldom critiqued outside the disciplines of health economics and public health. The objective of this systematic review is to collate, review and synthesize evidence-based economic estimations of the burden on society of work-related violence. A research protocol was developed and peer-reviewed a priori, examining both the academic and grey literatures. Ten cost-of-illness studies met the inclusion criteria and were reviewed. All studies used a bottom-up (person-based) approach to derive their economic estimates, with only two national-contexts examined. In general, a limited number of indirect (productivity-related) and intangible cost components were accounted for in the cost-of-illness studies. The reviewed studies were notably dated, with only two published post-2010. The derived economic estimates ranged from \$ 2.36 million to \$ 55.86 billion (figures inflated to 2016 US dollars). We conclude that much of the available evidence provides an informative, but possibly dated estimate, of the cost of incidents of work-related violence at the ‘sharp-end’ of exposure. Possibly such estimates are gross under-valuations, under-representing the true burden to society. This first systematic review in the area identifies key limitations in the operationalization and measurement of the construct of work-related violence within cost-of-illness studies. We argue such critiques should frame and deepen our understanding of economic estimates in this domain. Future directions are discussed.

Keywords: work-related violence, work, economic estimates, cost-of-illness studies, systematic review

Estimating the Economic Burden on Society Posed by Work-related Violence: A Systematic Review of Cost-of-Illness Studies

1. Introduction

Work-related violence has long been seen as a major occupational safety and health (OSH) issue by workers (Eurofound, 2013; Hoel, Sparks, & Cooper, 2001; Piquero, Piquero, Craig, & Clipper, 2013; Rogers & Kelloway, 1997), organisations (Baron, 2000) and policy makers (Leka, Jain, Iavicoli, Vartia, & Ertel, 2011). All forms of violence have the ability to cause harm, including injury and distress, to those workers who are exposed to them (Living & Conditions, 2015). The impact of exposure to work-related violence may result in physical injury; but irrespective of physical harm, victims may suffer distress and post-traumatic stress reactions (Schat & Kelloway, 2005). Such psychological reactions may result from being a witness to an incident of violence or being a victim more directly (Barling, Dupré, & Kelloway, 2009; Leather, Cox, & Farnsworth, 1990; Rogers & Kelloway, 1997). In preceding decades, the empirical developments in this field have yielded a good, albeit by no means exhaustive, understanding of the antecedents, mechanisms, and consequences associated with exposure to work-related violence (Flannery, 1996; Leather et al., 1990; Piquero et al., 2013). Consequently, there now exists a reasonable understanding of the characteristics and processes that can define effective workplace interventions (London, 2013; Wassell, 2009).

The human and organisational costs of direct and indirect (vicarious) exposure to acts or threats of work-related violence are described in the existing literature (Barling, 1996; Flannery, 1996; Leather, Lawrence, Beale, Cox, & Dickson, 1998). However, comparatively less attention has been paid to understanding the economic cost(s) associated with exposure to this occupational hazard. This is despite indications that these costs are likely to be sizable

to individuals, organisations, and society-at-large (Hoel et al., 2001). Cost-of-illness (COI) studies are a type of economic analysis, that aims to identify and measure the costs (in monetary terms) associated with the occurrence and impact of a particular disease, illness, or incurred injury to society-at-large (Byford, Torgerson, & Raftery, 2000).

From a policy perspective, such estimates can in principal, be used to: (1) define the magnitude of the disease or injury in fiscal terms; (2) justify intervention programs; (3) assist in the allocation of monetary resources for research; (4) provide a basis for policy and planning relative to prevention and control initiatives; and (5) provide an economic framework for program evaluation (Rice, 2000). Consequently, we argue that understanding the findings and nature of COI studies could provide the OSH community with a body of evidence by which to estimate the financial burden posed by exposure to work-related violence on society. However, it is important to note that within the field of economics the empirical value of COI studies is not universally agreed. It is beyond the scope of this review to summarize and capture the nuances this scholarly debate, but we encourage the interested reader to see (Rice, 1994; Rice, 2000; Shiell, Gerard, & Donaldson, 1987; Tarricone, 2006).

1.1.1. Investigating the economic burden of work-related violence: study rationale

For many in the field of OSH and beyond, such cost estimates are important sources of information. Such economic estimates are commonly used to exemplify and communicate the scale and impact of disease, illness or injury; and, in turn, are often used to support the development of a business case encouraging prevention and recursive management (Koopmanschap, 1998). However, until recently, detailed evaluations of such economic estimates have seldom received attention in the broader OSH literature. Some frequently cited figures have been produced without any clear specification or transparency in their employed methodology (Hassard et al., 2014). Recent empirical work has critically and systemically examined the available COI studies estimating the economic costs associated

with exposure to work-related stress (Hassard, Teoh, Visockaite, Dewe, & Cox, 2018b) and psychological and social forms of workplace aggression (e.g., bullying, mobbing; Hassard, Teoh, Visockaite, Dewe, & Cox, 2018a) to society. Such reviews have yielded important insights and conclusions regarding the breadth, depth and empirical rigour of current knowledge in this field. However, to date no such work has been conducted in the area of work-related violence. Consequently, we feel there is a need for the OSH community to: (i) develop a macro-level understanding of the nature and extent of the economic burden posed by exposure to work-related violence to society; (ii) gain a more in-depth and critical understanding on how and where such figures are derived; and (iii) identify important gaps in knowledge, which can be used to inform the research agenda in this field.

1.2. Work-related violence: a brief introduction

1.2.1. Conceptual understanding

There are numerous conceptual and operational definitions of work-related violence (Barling et al., 2009). In 1997, the European Commission sought to bring cohesion across existing definitions and agreed to define work-related violence as any incident where a person is abused, threatened or assaulted in circumstances related to their work, where such acts involve an explicit or implicit challenge to their safety, wellbeing and/or health. The proposed definition acknowledges that exposure can be a one off incident or represent a more recurrent pattern of behaviour (Wynne, Clarkin, Cox, & Griffith, 1997). This definition yields several important conceptual considerations. First, it implicitly includes both physical acts of violence, but also psychological violence (e.g., verbal threats or intimidation of harm or injury; Jenkins, 1996). This, therefore, permits a broad and diverse range of acts and behaviours to be accounted for within this construct, including: occupational homicide, physical and sexual assault, and threats or intimidation of physical and sexual violence.

Second, it conceptualizes harm beyond exclusively physical injury, but also accounts for the negative impact to victims' psychological health and social wellbeing. Third, it acknowledges that exposure to such incidents may occur across a range of work-related circumstances and perpetrators (e.g., co-workers, clients, patients, unknown assailants or terrorists).

We would argue that a notable limitation of this agreed definition is that it does not account for indirect (or vicarious) exposure to work-related violence, for example witnessing a violent incident (Lerias & Byrne, 2003) as a bystander, or listening to descriptions of such a horrific events (Schauben & Frazier, 1995). A sizable body of research has observed exposure to vicarious (acute or chronic) forms of violence to be associated with post-traumatic stress reactions (often referred as secondary trauma; Jenkins & Baird, 2002; Lerias & Byrne, 2003). Vicarious exposure to work-related violence can be associated with negative health and performance consequences (e.g., Bober & Regehr, 2006; Bowie, 2002; Lerias & Byrne, 2003). We would, therefore, strongly argue that vicarious exposure to work-related violence should be included and accounted for in the conceptual understanding and the operationalization of this construct. Therefore, the current study includes this unique 'exposure-harm' pathway within its conceptual understanding of this occupational phenomenon (see Figure 1).

[insert Figure 1]

1.2.2. Conceptualizing the cost of work-related violence

To understand the cost of work-related violence, two key areas need to be critically considered: first, the relationship between exposure to (physical and psychological) work-related violence and individual- and organisational-level outcomes; and, second, how such observed outcomes relate to the cost components utilised by COI studies to estimate the economic impact of this occupational phenomena. Drawing on findings from the existing

literature, and underpinning such considerations within our conceptual understanding of work-related violence, we aim to map and discuss possible exposure-related pathways (see Figure 1).

Cox and Leather (1994) and Barling (1996) have argued for the adoption of a stress-based model as a means of conceptualizing the negative impact of work-related violence at multiple-levels: *individual, organisational and societal*. Such an approach draws strongly from transactional models of stress theory (Cox, 1978), which seek to describe the process by which exposure to the noxious aspects of the work environment drives the experience of stress, the individual's appraisal and reaction to it, their attempts to cope, and its effects on their health and behaviour. In such a stress-based model, *threatened* or *actual* violence is usually deemed to constitute an acute stressor in the work environment (Kleber & van der Velden, 2009). Although it is equally possible that the on-going threat of violence might represent more of a chronic stressor. The impact of exposure to work-related violence, whether acute or chronic, is found to be associated with a wide range of negative outcomes at both the individual- (e.g. physical injury and harm, job dissatisfaction, impaired psychological and social well-being, and increased psychological withdrawal) and organisational-levels (e.g., absenteeism, decreased commitment to organisation, intention to leave; Barling, 1996; Barling, Rogers, & Kelloway, 2001; J. W. Budd, Arvey, & Lawless, 1996; LeBlanc & Kelloway, 2002; Rogers & Kelloway, 1997; Teoh, Hassard, & Cox, 2018). Therefore, this permits both direct and vicarious forms of exposure to be viewed as potentially hazardous in nature. This offers a conceptual advantage when seeking to understand the impact of work-related violence. There is a logical relationship between the aggregated human and organizational costs associated with the exposure to work-related violence, and the economic burden posed to individuals and society. The key characteristics

of COI studies, and the accounted for cost components (direct, indirect and intangible), are discussed in greater detail below.

1.3. Cost of illness studies: key characteristics

While many readers may be familiar with COI studies and their key methodological characteristics, we anticipate that there are others who may not be. Therefore, the current section aims to provide a short introduction to this methodological approach as commonly used in the field of health economics and public health. For a more comprehensive review see Larg and Moss (2011).

COI studies aim to estimate the total economic impact of a disease incurred by all relevant stakeholders within society (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2005), with such cost estimates (ideally) accounting for various and multiple associated economic dimensions and associated costs (Dagenais, Caro, & Haldeman, 2008). The objective of COI studies is primarily to itemize, value and sum the costs of a particular problem (Koopmanschap, 1998). Such studies typically stratify costs into three respective costs categories: direct, indirect and intangible costs (Dagenais et al., 2008; Jo, 2014; Lippa, Heinrich, Angermeyer, König, & Riedel-Heller, 2007; Molinier et al., 2008).

Direct costs are incurred by the healthcare system, family, society and the individual; and typically consist of healthcare (e.g., expenditure related to diagnosis, treatment and rehabilitation) and non-healthcare costs (e.g. transportation, household expenditures, relocating, property losses, litigation; (Dagenais et al., 2008; Jo, 2014; Lippa et al., 2007)).

Indirect costs refers to productivity losses due to mortality or morbidity borne by the individual, family, society or the employer (Gold, Siegel, Russell, & Weinstein, 1996). The majority of studies focus on productivity losses incurred within the occupational context (e.g., sickness absence and turnover; (Béjean & Sultan-Taïeb, 2005; McTernan, Dollard, &

LaMontagne, 2013). Comparatively fewer studies account for non-work related productivity losses, for example: housework, voluntary work and other unpaid productivity work; (Larg & Moss, 2011; Molinier et al., 2008). *Intangible costs*, in contrast, reflect the monetary value prescribed to the pain and suffering, and the reduced quality of life experienced by the afflicted individual or group of individuals (Luppa et al., 2007).

COI studies can be categorized as either top-down or bottom-up in methodological approach (Drummond et al., 2005; Larg & Moss, 2011). The *top-down (population aggregated-based) approach* measures the proportion of a disease or health problem that is due to exposure to the disease or risk factor (Larg & Moss, 2011). Attributable costs are calculated by using aggregated data along with population-attributable fraction (Morgenstern, Kleinbaum, & Kupper, 1980). *The bottom-up (person-based) approach* estimates costs by calculating the estimated cost per case and extrapolates it to the national level. In this instance, medical expenditure and/or loss of productivity are costed per person/case, and then multiplied by the number of cases or persons affected (Larg & Moss, 2011).

1.4. Aim of the Current Study

The aim of the current study is to collate, review and synthesize evidence-based economic (monetary) estimations of the economic burden posed by exposure to work-related violence at the level of the individual and society. More specifically, we aim to: (i) describe identified COI studies; (ii) classify and categorize their main objectives and methodological approach; (iii) compare the observed results; and, finally, (iv) to consider the implications of such findings in relation to research in the field of OSH.

2. Method

Prior to the commencement of the study, a scoping review of the literature was conducted to inform the development of the research protocol. The systematic review was

informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher, Liberati, Tetzlaff, Altman, & Group, 2009) guidelines.

2.1. Search Strategy

Using an inclusion period covering the start of the database used until October 11th, 2017, five databases were searched: Ingentaconnect, EBSCO (Academic Search Premier, Business Source Premier, PsychArticles, PsychInfo), JSTOR, Science Direct and Web of Knowledge (Medline, Web of Science). The research question was separated into three facets with free text variants identified for each one: violence (aggression, homicide, abuse, threaten, assault), cost (financial cost, economic cost, monetary cost, cost-of-illness, economic evaluation, illness costs, medical costs, health costs), and occupational setting (work, job, occupation). To expand beyond the academic databases, we additionally searched the first ten pages each of Google and Google Scholar and examined the websites of NGOs (e.g., World Health Organization) and relevant public bodies (e.g., US National Institute for Occupational Safety and Health).

Included articles were required to cumulatively meet five inclusion criteria. The article had to: (i) refer to violence or one of its associated dimensions (homicide, assault, threats, intimidation, aggression or violence); (ii) be set within a work-related context; (iii) be a COI with a documented methodology; (iv) costed at the individual, societal or national level (e.g., costs borne by an individual, national health insurance/ service, economy, or government); and (v) be published in English. No restrictions were placed on the approach or methodologies used to obtain the financial figure quoted.

2.2. Data Extraction and Quality Assessment

To standardize the extraction and synthesis process, a data extraction form was developed and, subsequently, piloted. Data were extracted across five domains: study

background, methodological design, population, costs and sub-costs and a study quality assessment checklist. The checklist is based upon the ten-item health economic quality checklist (Drummond et al., 2005) that was adapted by Hassard and colleagues for their recent systematic reviews of COI studies examining work-related stress (2018b) and psychosocial aggression (2018a). The adapted checklist was used for the current study.

Each study was evaluated against ten criteria outlined in the quality assessment checklist. These criteria critically examined the following methodological and conceptual domains: (i) specification of the utilized definition of work-related violence and theoretical grounding of the study; (ii) descriptive clarity of epidemiological sources used; (iii) detail in the disaggregation of total costs into appropriate sub-costs; (iv) transparency in the utilized activity data. This refers to data linking epidemiological statistics [prevalence or incidence statistics] with an appropriate health or work outcome (e.g., odds ratios or relative risk; or that number of sick days/ reduction in productivity among workers that have experienced violence); (v) outlining and critically evaluating the nature all cost values used; (vi) identification of unit costs and consideration of their given value; (vii) provision of methodological detail of study parameters; (viii) the use of discounting (where appropriate); (ix) the use of sensitivity analysis; and (x) presenting the results of the study consistently in relation to the utilized methodology.

Discounting refers to the adjustment of costs to reflect future costs having less of a value than present day costs (Mauskopf, 1998). This analytical procedure should be conducted where costs extend over a one year period. Discounting makes current costs and benefits worth more than those occurring in the future (Torgerson & Raftery, 1999). The economic models derived by COI studies are complex; and, consequently, contain many uncertainties and unknowns. Sensitivity analysis permits testing the robustness of the results by varying in range key variables (e.g. prevalence, unit costs, etc.; (Costa et al., 2012).

In order to comparatively evaluate the studies and attempt to rank them accordingly, a scoring system was employed. The utilized ranking system was previously used in published COI reviews (Hassard et al., 2018a; Hassard et al., 2018b). The checklist included ten quality assessment criteria. A score was given in relation to each specified criteria (0 = criterion not met, 1 = partially met, 2 = fully met). The score for each criterion were summed to provide a composite score for each study. A method of weighting was not used in relation to the ten criteria as such an approach has not been used or validated in previous COI reviews. Studies were categorized based by their yielded composite score: good (aggregated scores between 16 and 20), average (8 to 15), or poor quality (1 to 7). Each included study was independently rated by two reviewers, and differences discussed until consensus was obtained. No studies were excluded based on quality as it allowed for an examination of the diverse range of studies examining work-related violence; and their respective empirical and methodological quality.

2.3. Review Process

The database searches obtained 211 studies, which were supplemented with an additional 59 studies identified through the non-database searches (Figure 2). Identified studies were reviewed using a two-stage review process: (i) title and abstract, and (ii) full-text. After 60 duplicates were removed, the remaining 210 abstracts were reviewed. In the first stage, 173 studies were excluded as their abstracts did not meet one of the three inclusion criteria applied at this stage of the review, which were the first three of the five inclusion criteria: (i) refer to violence or one of its related terms; (ii) set within a work-related context, or (ii) was a COI study. This process resulted in 37 full-text articles left to be assessed in the second stage of the review. All five of the specified inclusion criteria were applied to the full-text review of short-listed studies. Each stage of the review process was independently

carried out by two reviewers who each reviewed each study. No conflicts were observed between the two reviewers and full consensus was achieved at both stages.

[insert Figure 2]

3. Results

In total, the search strategy found ten studies that met the specified inclusion criteria. Nine out of the ten included studies examined data from the United States, including five that investigated American states specifically: Minnesota (n=1; (McGovern et al., 2000), Oregon (n=2; (McCall & Horwitz, 2004; ODCBS, 1996) and Washington (n=2 (Foley & Rauser, 2012; Nelson & Kaufman, 1996). The tenth study examined England and Wales (T. Budd, 1999). Table 1 presents a descriptive summary of the conceptualization of work-related violence, and its respective operationalization in each study. All ten studies included in this review used a bottom-up approach, where the mean cost per case of work-related violence was first estimated. To obtain the final economic estimate, eight of these studies extrapolated the costs per claim to either the national- or the state-level. No studies utilising a top-down approach were identified by the review process.

[insert Table 1]

3.1 Quality Assessment of Included Studies

Table 2 maps each study against the ten COI quality assessment criteria. The majority of studies were rated as “good” in methodological quality (n=8); with one rated “average” and another “poor”. McCall and Horwitz (McCall & Horwitz, 2004) was the only study to meet all applicable quality assessment criteria, with an additional four studies (Hartley, Biddle, & Jenkins, 2005; Nelson & Kaufman, 1996; ODCBS, 1996; Speroni, Fitch, Dawson, Dugan, & Atherton, 2014) at least partially meeting the applicable study-relevant criteria. As

bottom-up approaches typically aggregate actual costs spent by/on an individual, there is an absence of future costing or assumptions on costs being made. Therefore, the bottom-up approach employed by all reviewed COI studies meant that criteria pertaining to cost discounting and sensitivity analysis were largely not applicable. In general, the lack of comprehensive details in study characteristics and utilized data sources was the primary reason a study did not fully meet the applied quality assessment criterion, and were, thus, awarded a partial mark (i.e., 1).

3.2. Taxonomy of work-related violence

Table 3 presents a conceptual summary of the facets of work-related violence examined across the identified studies. Two studies focused solely on one form of work-related violence: occupational homicides (Biddle & Hartley, 2002; Hartley et al., 2005). The remaining studies considered non-fatal forms of work-related violence. All eight studies considered assaults and violent acts, with some additionally specifying these as kicking (n=3), biting (n=4), striking or beating (n=4), squeezing and pinching (n=2), and shooting or stabbing (n=4). Four studies included rape and sexual assault (Kaufman & Mattman, 1998; McCall & Horwitz, 2004; McGovern et al., 2000; Nelson & Kaufman, 1996). Verbal threats or intimidation of physical and sexual violence was considered in five studies (T. Budd, 1999; Kaufman & Mattman, 1998; McCall & Horwitz, 2004; Nelson & Kaufman, 1996; ODCBS, 1996). Finally, two studies (Kaufman & Mattman, 1998; ODCBS, 1996) considered both homicides and non-fatal work-related violence incidents.

[insert Table 3]

3.3. The incidence rate of work-related violence

See Table 4 for a summary of the incidence statistics used across the reviewed COI studies. At the state-level: the incidence rate of claims was 1.84 claims per 10,000 full-time

equivalent workers in Minnesota (McGovern et al., 2000); ranged between 1.86 to 3.3 (per 10,000 workers) in Oregon (McCall & Horwitz, 2004; ODCBS, 1996); and between 13.5 to 19 (per 10,000 workers) in Washington State (Foley & Rauser, 2012; Nelson & Kaufman, 1996). The rate of homicides per 10,000 workers was 0.07 for the entire United States (Hartley et al., 2005). Despite providing the source for their sample, two studies did not report the actual incidence rate of work-related violence utilised in their COI study (Biddle & Hartley, 2002; Kaufer & Mattman, 1998).

Speroni et al. (Speroni et al., 2014) drew on compensation claim data from a hospital and found a rate of 59.8 per 10,000 nurses (i.e., 0.598%) incurred treatment costs due to exposure to work-related violence. This was substantially lower than the 2.1% who reported violence to the hospital health department, and the 76% who through an internal organizational survey responded they had been exposed to work-related violence. These different incidence rates reflect the nature of the data source utilised. High incidence rates when using self-report surveys is also evident in Budd (1999), who used data from the British Crime Survey. This survey observed 28% of participants (i.e., 2,800 per 10,000) reported that they had been threatened or assaulted at work in the preceding year.

[insert Table 4]

The data from which the incidence statistics above were drawn from across varied timeframes and source (See Table 4); and were, in generally, notably dated. The incidence data for seven of these studies were collected in 1990's. Although two additional studies included data collection that extended until 2001 (Hartley et al., 2005) and 2007 (Foley & Rauser, 2012). Speroni et al. (Speroni et al., 2014) used data from 2010, and of the reviewed studies was the most contemporary source of evidence. Two studies were published a year after the data was collected, with the remaining studies published three (Kaufer & Mattman,

1998), four (Hartley et al., 2005; Nelson & Kaufman, 1996; Speroni et al., 2014), five (Biddle & Hartley, 2002; Foley & Rauser, 2012) or even later (McCall & Horwitz, 2004; McGovern et al., 2000). Nine out of ten studies obtained the extent of work-related violence by examining administrative databases on the number of compensation claims or fatality records – either at state or national level. Five studies drew on incidence data from a single year; with the remaining five studies drawing incidence data across a five (ODCBS, 1996), eight (Biddle & Hartley, 2002; McCall & Horwitz, 2004) or ten (Foley & Rauser, 2012; Hartley et al., 2005) year period.

3.4. Type of costs examined

Nine of the ten studies specified the types of costs that were used within their economic estimation methods (see summary in Table 5). These costs were separated into intangible, direct, and indirect costs; and are discussed below. However, the study by Kaufer and Mattman (Kaufer & Mattman, 1998) did not specify the exact cost components used and is, therefore, not discussed in the following section.

[insert Table 5]

3.4.1. Intangible costs

Only one of the ten studies accounted for intangible costs in their economic estimate of work-related violence (T. Budd, 1999). This study aimed to estimate the non-material cost of work-related violence in England and Wales. To obtain this cost, participants of the British Crime Survey indicated how much compensation they felt they deserved for the upset and inconvenience suffered due to experiencing assault and threats. There was substantial variability in responses, with 63.8% of participants not wanting any compensation, while 3.8% desired in excess of \$634. *3.4.2. Direct costs*

Eight studies examined the medical costs incurred. These costs were derived from state (Foley & Rauser, 2012; McCall & Horwitz, 2004; Nelson & Kaufman, 1996; ODCBS, 1996) or national (Biddle & Hartley, 2002; Hartley et al., 2005) compensation statistics, or from insurance records (McGovern et al., 2000; Speroni et al., 2014). McGovern et al. (McGovern et al., 2000) was the only study to specify the medical costs included in their study, including: physician and nursing services, hospital charges, drug costs, rehabilitation services, ambulance fees, and payments for medical equipment and supplies. Direct non-medical costs were estimated by four studies: vocational rehabilitation (McGovern et al., 2000); and legal, administrative, compensation, and other expenses (McCall & Horwitz, 2004; McGovern et al., 2000; Nelson & Kaufman, 1996; Speroni et al., 2014). Two further studies examined indemnity payments (ODCBS, 1996; Speroni et al., 2014) and partial permanent disability benefits (McCall & Horwitz, 2004; ODCBS, 1996). These data were obtained from state (McCall & Horwitz, 2004; ODCBS, 1996) and insurance records (McGovern et al., 2000; Speroni et al., 2014).

3.4.3. Indirect costs

Seven of the eight studies accounted for both direct and indirect costs in their economic estimates of work-related violence. These consisted of productivity-loss through early death (n=2; Hartley et al., 2005), sickness absence (n=4) or loss of earnings (n=1). Different definitions of sickness absence between different states was observed. Washington (Foley & Rauser, 2012) and Minnesota (McGovern et al., 2000) considered sickness absence claims as those exceeding four or more days, while in Oregon (McCall & Horwitz, 2004; ODCBS, 1996) it was three or more days. To estimate the cost of sickness, absence the number of days lost were multiplied with the individual's daily wage rate. A similar methodology was used to estimate loss of productivity due to early death, where the future earnings between the year of the deceased's death until the year they would have turned 67

was estimated (Hartley et al., 2005). This is accomplished by using the median wage of the deceased's age, sex and occupation. Two studies costed the indirect non-productivity costs (Hartley et al., 2005; McGovern et al., 2000), which included activities such as housework and child care. Data was drawn from previous studies (Douglass, Kenney, & Miller, 1990) where a monetary value was assigned to different nonmarket activities by using the wage of a similar specialist (e.g., cook, home cleaner) as a proxy before it was multiplied by the number of hours spent on each activity.

3.5. Cost of work-related violence

To allow a descriptive comparison of costs published across different years, the original presented costs in each study were inflated to 2017 cost figures using country specific consumer price indexes (specified to December 31st, 2017). For the study that presented costs in British pounds (T. Budd, 1999), costs were then converted to U.S. dollars using purchase power parities (World Bank, 2017). The derived economic estimates at the national-and state-level are presented first, this is followed by studies that examined costs at the individual-level (i.e., mean cost per case of work-related violence). Finally, where possible, a breakdown of the proportion of the different costs that make up the derived economic estimate is provided.

In the United States, Kaufer and Mattman (Kaufer & Mattman, 1998) estimated the cost of work-related violence at \$55.86 billion a year (see Table 1 for summary). In England and Wales, the intangible cost of work-related violence was estimated at \$176.43 million annually (T. Budd, 1999). At the state-level, incidents of work-related violence was estimated to cost \$8.99 million in Minnesota annually (McGovern et al., 2000), \$2.36 million in Oregon (McCall & Horwitz, 2004), and between \$9.16 (Nelson & Kaufman, 1996) and \$22.9 million (Foley & Rauser, 2012) in Washington. Focusing specifically on work-related homicide, the

national annual cost in the United States ranged between \$868.69 million (Hartley et al., 2005) to \$1.02 billion (Biddle & Hartley, 2002). Two studies (ODCBS, 1996; Speroni et al., 2014) did not extrapolate their costs to the state- or national-level.

At the individual-level, the mean per case of work-related violence varied substantially from \$54 (T. Budd, 1999) up to \$1.16 million (Biddle & Hartley, 2002), with this range dependent on the study's focus and the cost components accounted for. The studies yielding the highest estimate per case were work-related homicides, with two studies costing each case at approximately \$1.20 million (Biddle & Hartley, 2002; Hartley et al., 2005). A third study (ODCBS, 1996); which only considered medical and indemnity costs and not productivity loss due to early death, obtained costs of \$170,769 per fatal case of work-related violence. Budd (T. Budd, 1999), who only costed the non-material cost of work-related violence, found the intangible cost of an assault to be \$279 per case; with exposure to verbal threats of injury or harm costing an estimated \$54.

For the six studies that focused on the tangible costs of non-fatal work-related violence incidents, the mean of each case was typically around \$10,000; with four studies having a range between \$9,310 and \$13,877 per case (Foley & Rauser, 2012; McCall & Horwitz, 2004; ODCBS, 1996; Speroni et al., 2014); see Table 1). Interestingly, the study with the highest cost per case (\$26,126; (McGovern et al., 2000) also utilised the lowest rate of work-related violence (1.84/10,000) within these six studies. In contrast, the study with the highest rate of work-related violence (19/10,000) observed the lowest cost per case of work-related violence: \$3,824 (Nelson & Kaufman, 1996).

3.5.1. Comparison of direct and indirect costs

Only four studies provided sufficient information to compare the proportion of costs that make up the economic estimate of incidents of work-related violence. Figure 3 illustrates

the proportion of the direct (healthcare, non-healthcare) and indirect (productivity loss, non-productivity loss) costs of work-related violence. Loss of productivity (due to sickness absence) accounted for about a third of the total costs, while medical costs ranged from 25% to 57% (see Table 5). The two studies that did include indemnity payments found these to make up 75% and 92% of the total costs in non-fatal and fatal cases respectively (ODCBS, 1996; Speroni et al., 2014); in both these studies medical costs made up the remaining proportion of the derived economic estimates.

[insert Figure 3]

4. Discussion

The aim of the current study was to collate, summarize and evaluate COI studies investigating the economic burden posed by work-related violence to the individual and society. The review identified ten COI studies meeting the specified inclusion criteria, all using a bottom-up (person-based) approach to derive their economic estimates. Based on the available evidence, the estimated cost of work-related violence was observed to range from \$2.36 million to \$55.86 billion (figures inflated to 2017 \$US) across studies.

In general, the empirical strength and rigor of such economic estimates is notably high. However when such studies are considered at a macro level, we conclude that this body of literature is characterised by several notable conceptual and methodological limitations. The reviewed studies were drawn from a limited number of national contexts (United States, and England and Wales), and accounted for a limited number of indirect (productivity-related) and intangible cost components. Furthermore, a dearth of contemporary economic estimates was identified by this review, with only two studies published and data used corresponding to a period after 2012. This broadly corresponds, to our subjective assessment of the broader literature in the area of work-related violence; which appears to have

diminished in recent years, despite continued gaps in knowledge and evidence-based practice within this field. For example, Hassard and colleagues (2018b) observed that the majority (83.3%) of COI studies examining psychosocial workplace aggression were published post-2006. In direct contrast to the current study, which observed 80% (8 out of 10 studies) were published pre-2006: 40% \leq 1999 and 40% 2000-2005. We speculate whether the growing academic interest and burgeoning literature examining the nature and impact of psychological and social (psychosocial) forms aggression at work (e.g., bullying, harassment) in recent decades has resulted (directly or indirectly) in a decrease empirical interest in area of work-related violence. Consequently, a simple ~ but important question ~ is: can we assume that the economic estimates of yester-year continue to be (as) valid and reliable today? Considered collectively, does this observation suggest that field of OSH has ‘falling out of love’ with research examining the impact of work-related violence, and whether an empirical renaissance is needed?

4.1. Work-related Violence: Conceptualization and Operationalization

The current state of knowledge of the economic impact of exposure to work-related violence is limited and, in many ways, narrowly defined and measured. Such limitations broadly relate to: the conceptualization and operationalization of work-related violence; the epidemiological perspective used by the majority of studies; and notable limitations with the utilised sources of data. It is our assessment that all available economic estimates (as identified by this review) are accounting economically for the ‘sharp-end’ of the exposure continuum for work-related violence (e.g., occupational homicide, physical or sexual assault). We propose an iceberg model to represent the current status of the economic modelling of the burden posed by work-related violence (see Figure 4). The ‘tip of the iceberg’ is, by and large, accounted for well in existing economic models. However, those more ‘hidden’ forms of violence and associated cost components (indirect and intangible cost components) are not.

Consequently, their economic impact ‘lies below the surface’. We conclude, therefore, the available economic estimates in this domain are likely gross under-valuations of the ‘true’ economic burden posed by work-related violence. The proceeding sections will provide a more detailed reflective discussion on each noted point.

[insert Figure 4]

4.1.1. Defining work-related violence: are we missing the bigger picture?

Within the OSH domain, work-related violence is acknowledged and understood as a complex, multi-faceted construct (Barling, 1996; Cox & Leather, 1994; Leather et al., 1990). It is our assessment that this conceptualization, as understood within the psychosocial and OSH literatures respectively, is not – at present- comprehensively represented within the available economic figures in this domain. *Why?*

The majority of COI studies operationalized the construct of work-related violence in, arguably, a conceptually limited manner, accounting for a narrow range of violent acts and behaviours. In particular, physical acts and behaviours of violence are strongly conceptually represented. What is, comparatively, less accounted for in the operationalization of this construct are psychological forms of work-related violence; and, in turn, the psychological impact of (direct or vicarious) exposure to all forms of violence (physical or psychological). This is despite recent trends within the working population that suggests exposure rates of physical violence are decreasing; while, comparatively, psychological acts (e.g., threats of harm or injury or physical intimidation) of violence are increasing in frequency and occurrence (Eurofound, 2013).

A separate, although clearly strongly related literature, has examined individual’s response to vicarious trauma (or secondary trauma stress) in terms of health (e.g., depression,

anxiety and burnout) and organizational (intention to leave) outcomes (Baird & Jenkins, 2003; Bride, 2007; Collins & Long, 2003). There is (growing) evidence of the relevance and importance of considering this exposure pathway in the prevention and management of work-related violence (Barling et al., 2009; Barling et al., 2001). Although, we would argue that its conceptual integration within the broader work-related violence literature requires further attention and effort. It is due to this empirical rationale that we integrated this exposure pathway into our study's conceptual model, as we feel there is sufficient evidence to demonstrate its impact at the individual- and organizational-levels. Therefore, by conceptual extension, we would postulate that the human and organisational impact of this vicarious exposure pathway will have associated costs related to: healthcare (direct cost), productivity losses (indirect costs) and an adverse impact to workers quality of life (intangible costs; see Figure 1). The results of this study highlight two important observations: first, this vicarious pathway of exposure was not included in the conceptualisation or operationalization of the construct of work-related violence within reviewed studies; and second, by clear extension, form of exposure was not accounted for in any of the available economic estimates. Consequently, such a conceptual omission yields a narrow and restricted empirical view into the economic burden posed by work-related violence to society.

4.1.2. Quantify the scale of exposure: an issue of measurement

The COI studies reviewed use measurements of work-related violence that quantify only the 'sharp-end' of exposure, including for example: homicide and serious physical assault necessitating a considerable time off work (and which are formally reported in some manner). It is commonly acknowledged that non-fatal injuries (including direct acts of physical and psychological harm and vicarious exposure) where time off work was not taken are drastically under-estimated and under-represented by such sources of data (Piquero et al., 2013). Estimated exposure rates derived from community-based surveys, typically using

subjective reporting measures, suggest the scale of work-related violence is considerably larger than estimates using objective measures (e.g., RIDDOR, Bureau of Labour Statistics, or state or provincial workers compensatory systems; (Piquero et al., 2013).

We would argue that self-reported measures of work-related violence provide a broader (and arguably more inclusive view) of the ‘true’ scale of exposure to work-related violence, and better accounting for both direct and vicarious exposure to physical and psychological acts of work-related violence. However, such sources of information are not without their limitations and criticisms (Eurofound, 2013). This is likely for two key reasons. First, surveyed workers may not want to identify as a victim or target of work-related violence resulting in potential under-reporting. Second, workers subjected to serious instances of physical harm or psychological violence are likely to have already withdrawn from the labour market and, therefore, will not appear in survey samples (Eurofound, 2013). The so-called healthy worker effect (Li & Sung, 1999)

In short, at present, there is a dearth of good quality sources of epidemiological data, which yield an inclusive and comprehensive view of the likely scale of work-related violence at the national and supra-national level (Piquero et al., 2013). We can conclude that of the available evidence that a sizable proportion of the working population is exposed to acts of work-related violence; however, it is likely the true scale of this problem is largely underestimated and, by extension, the economic burden posed by this occupational hazard is grossly underestimated.

4.1.3. Accounting for diverse costs associated with exposure to work-related violence: health, productivity and beyond

A consideration of the cost components included (and, in turn, not included) by the reviewed COI studies yields an important interpretative lens in which to evaluate the

available economic estimates. The established view, and considered best practice, is that cost components derived from all three cost categories should be included in economic models: direct, indirect and intangible costs (Dagenais et al., 2008; Molinier et al., 2008). By doing so, a comprehensive and, arguably, more accurate estimate of the financial burden posed by work-related violence can be achieved. Among reviewed studies, direct and indirect cost components were included in the majority of economic models developed. There was an overall tendency to account for a wide range of direct costs (both medical and non-healthcare related resources) components; and, comparatively, a narrower range of productively-related costs, primarily sickness absence. In relation to indirect costs (or productivity-related costs), two particular costs components were typically absent in many of the economic estimates: turnover and presenteeism. Preliminary evidence suggests that such cost components may carry a sizable monetary value (Kigozi, Jowett, Lewis, Barton, & Coast, 2017). For example, presenteeism is estimated to cost 1.5 to 10 times more than sickness absence (McTernan et al., 2013). A recent systematic review (Kigozi et al., 2017) examined the extent to which presenteeism is accounted for in COI studies and economic evaluation, and its relative impact to economic estimates. Like the current review, Kigozi et al. (2017) found a dearth of studies accounting for presenteeism in their economic models, and of those that did its monetary impact was both sizable and comparatively larger than that related to sickness absence. Kigozi et al. (2017) conclude the omission of the costs associated with presenteeism is a clear conceptual limitation within economic models. The direct consequence of which is gross undervaluation of the 'true' economic scale of impact.

The cost components associated with intangible costs are seldom included in economic models (Larg & Moss, 2011). In context of this review, only one study accounted for intangible (quality of life) costs (Budd, 1999). This failure is a noted methodological limitation that has defined many COI studies in other areas of health (Larg & Moss, 2011)

and health and safety research (Hassard et al., 2018a; Hassard et al., 2018b). Preliminary research, derived from allied health literature, observe that intangible costs constitute a significant, if not overwhelming, proportion of economic estimates. For example, 67% of the total cost of underage drinking was related to intangible costs (Miller et al., 2006), and 56% of the total cost of work-related ill-health (HSE, 2013). Arguably, the omission of intangible, and other important indirect, costs within economic estimates of work-related violence are a sizable methodological and conceptual omission; but also potentially a significant (and potentially costly) exclusion from derived economic estimates.

4.1.4. The Epidemiological Perspective: Incidence or Prevalence, does it really matter?

COI studies can adopt one of two epidemiological perspectives in their methodological approach: *incidence-based* (typically operationalized through a bottom-up approach) and *prevalence-based* approaches (a top-down approach). Previous COI reviews in related OSH-areas (Hassard et al., 2018a; Hassard et al., 2018b) have observed that the majority of studies adopt a prevalence-based perspective. In stark contrast, all reviewed COI studies in the current study used incidence statistics to inform their derived economic estimates, as operationalized through a bottom-up method. Given this divergence in epidemiological perspective, this raises an important question: does the epidemiological (incidence or prevalence) perspective utilized by the COI study influence how we interpret/understand such economic figures? Simply put, *yes*.

Prevalence-based approaches are viewed as the most appropriate method to calculate *the total cost of a disease or injury* (Larg & Moss, 2011), as prevalence statistics provide an estimate of the proportion of a population with a specific ailment or condition in a given time period. This approach includes a cross-section of cases and, therefore, provides a view of the associated costs at varying stages of disease or injury (Byford et al., 2000; Hodgson & Meiners, 1982). None of the reviewed studies utilized this epidemiological approach.

Therefore, an important conclusion from this review is at present the availability of good quality economic estimates of the total cost of work-related violence to society (*at worst*) do not exist; or (*at best*) were not identified by our comprehensive and rigorous search strategy. We fear that, at present, the latter is more likely; yielding a significant gap in knowledge and an important avenue for future research.

While incidence-based COI studies cannot speak to the total cost of work-related violence, what this body of research does, however, provide is an estimate of the economic cost of all new cases (incidents) of work-related violence within a given time period. Such economic evidence can, therefore, provide important economic evidence of the *averted costs (or savings) if new cases of work-related violence* are prevented (Larg & Moss, 2011). Consequently, such figures can inform the calculation of baseline costs for cost-effectiveness studies of preventive and therapeutic interventions (Finkelstein & Corso, 2003; Goldstein, Reznik, Lapsley, & Cass, 1986). Therefore, it is important to not interpret such economic figures as representative of the total economic burden of work-related violence to society. However, such economic estimates continue to provide an important source of evidence to support the argument for preventative action, and may yield important information to support the evaluation of cost-effectiveness studies for interventions.

4.2. Limitations of the current study

Two methodological limitations should be considered in relation to this review. First, by restricting the search strategy to articles in English, potentially relevant studies may not have been identified by the current search strategy. Therefore, the inclusion of wider spectrum of languages might have revealed a larger sample of articles and from a more diverse set of national contexts. Second, the adjustments made to obtain the average cost of

work-related violence per economically active person only permits a crude form of comparison between studies; and should be interpreted with a healthy degree of caution.

5. Conclusion

Much of the available evidence provides a good estimate (albeit not without their empirical and conceptual limitations) of the cost of incidents of work-related violence at the 'sharp-end' of exposure. However, such economic estimates do not, however, provide an accurate overview or estimate of the more 'hidden' forms of violence. In short, the available economic evidence provides us with a, at best, good indication of 'tip of the iceberg' in economic terms. However, 'below the surface' lies a number of costs and considerations that are not accounted in the available economic estimates (in either conceptual or economic terms). We argue that such 'hidden' costs (predominately to do with those more 'hidden' forms of work-related violence) are likely sizable in human and by extension economic terms; and, therefore, merit systematic investigation and, in turn, economic modelling. We would argue that to meaningfully understand and estimate the impact (in human and economic terms) of work-related violence we must consider and account for both the costs 'above and below the surface of the water'. In so doing, can we only then begin to understand what the 'true' economic burden posed to society by work-related violence is.

6. References

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Table 1: Overview of Studies and Economic Estimates

Study/ Country	Study aims	Form of work-related violence	Incidence rate of violence (per 10,000 workers)	Published costs			Costs adjusted to 2017 US\$	
				For the Year	Total cost	Cost per case	Total cost	Cost per case
Biddle & Hartley (2002) United States	To provide estimates of the societal cost of workplace homicide.	Homicide	-	1999	\$705.8 8 million	\$804,035	\$1.02 billion	\$1.16 million
Budd (1999) England & Wales	Estimate the non-material cost of workplace violence.	Assaults or threats	2800	1998	£180 million	Assaults: (£285); threats (£55)	\$176.43 million	Assault (\$279); threats (\$54)
Foley & Rausser (2012) Washington State, United States	To report on trends in the pattern of injuries related to workplace violence over the period 1997–2007.	Kicked, striking, beating, biting, shooting, or assault and violent acts	13.5	2007	\$19.33 million	\$8,848	\$22.29 million	\$10,202
Hartley et al. (2005) United States	To present the societal cost estimates of occupational homicides by worker and case characteristics.	Homicide	0.07	2001	\$633.7 million	\$799,621	\$868.69 million	\$1.20 million
Kaufer & Mattman (1998) United States	To report on to the frequency, cost, gender, age, industry, and nature of work-related violence injuries.	Fatalities, rapes, aggravated assaults, threats, or acts of harassment.	-	1995	35.4 billion	-	\$55.86 billion	-
McCall & Horwitz (2004) Oregon, United States	To provide a more detailed and in-depth analysis to workplace violence compensation data	Assaults and violent acts, hitting, kicking, beating, shootings, squeezing, pinching, scratching, stabbing, threats, verbal assaults, biting or rape	1.86	1997	\$1.57 million	\$6,200	\$2.36 million	\$9,310
McGovern et al. (2000) Minnesota, United States	To describe the long-term productivity costs of occupational assaults	The act of causing physical injury or harm, including sexual assault	1.84	1996	\$5.89 million	\$17,108	\$8.99 million	\$26,126
Nelson & Kaufman (1996) Washington State, United States	To describe the fatal and nonfatal injuries related to assaults and violent acts in Washington workplaces	Assaults and violent acts, hitting, kicking, beating, shootings, squeezing, pinching, scratching, stabbing, threats, verbal assaults, biting or rape	19	1992	\$6 million	\$2,504	\$9.16 million	\$3,824
ODCBS (1996) Oregon, United States	To examine the accepted disabling workers' compensation claims (involves more than three	Being struck, stabbed, beaten, shot, assaulted, bitten, and occupational	3.3	1995		Death: \$108,229; Non-fatal:		Death: \$170,769 Non-fatal:

	days of time loss, permanent disability, inpatient hospitalization or death) that resulted from violent acts between 1991-1995.	mental stress where the source is another person.			\$8,795	\$13,877
Speroni et al. (2014) United States	To research the incidence of workplace violence against nurses perpetrated by patients or visitors in their hospital system	Violence or the threat of violence against workers	59.8	2010	\$10,248	\$11,324

Table 2: Quality assessment of included studies

Quality Assessment Criteria Approach	Biddle (2002) BU	Budd (1999) BU	Foley & Rausser (2012) BU	Hartley et al. (2005) BU	Kaufer & Mattman (1998) BU	McCall & Horwitz (2004) BU	McGovern et al. (2000) BU	Nelson & Kaufman (1996) BU	ODCBS (1996) BU	Speroni et al. (2012) BU
1. Was a clear definition of the illness given?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2. Were prevalence sources carefully described?	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
3. Were costs sufficiently disaggregated?	Y	Y	N	Y	N	Y	Y	Y	Y	Y
4. Were activity data appropriately assessed?	N	Y	Y	Y	P	Y	Y	Y	Y	Y
5. Were the sources of all cost values analytically described?	P	P	Y	Y	P	Y	Y	P	P	P
6. Were unit costs appropriately valued?	P	Y	Y	P	N	Y	Y	Y	Y	Y
7. Were the methods adopted carefully explained?	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
8. Were costs discounted?	N	NA	NA	P	NA	NA	Y	NA	NA	NA
9. Were the major assumptions tested in a sensitivity analysis?	N	N	NA	P	N	NA	N	NA	NA	NA
10. Was the presentation of study results consistent with the methodology of study?	Y	Y	Y	P	P	Y	Y	P	Y	Y
Total Score	13	16	18	16	6	20	18	18	19	19
Study Quality	Average	Good	Good	Good	Poor	Good	Good	Good	Good	Good

Note. (Y) denotes criterion fully met and is worth 2 marks; (P) represents partially met and is worth 1 mark; (N) represents met not met and is worth 0 marks; NA means criterion not applicable; BU: Bottom-up.

Table 3: Taxonomy of work-related violence

	Threats of physical harm or intimidation	Assault or violent Act	Kicking	Biting	Striking or beating	Squeezing, pinching or scratching	Shooting or stabbing	Rape/ Sexual assault	Homicide
Biddle (2002)								X	
Budd (1999)	X	X							
Foley & Rausser (2012)		X	X	X	X		X		
Hartley et al. (2005)								X	
Kaufer & Mattman (1998)	X	X					X	X	
McCall & Horwitz (2004)	X	X	X	X	X	X	X	X	
McGovern et al. (2000)		X					X		
Nelson & Kaufman (1996)	X	X	X	X	X	X	X	X	
ODCBS (1996)	X	X		X	X		X		
Speroni et al. (2014)		X							

Table 4: Work-related violence sources of data utilised by identified studies

Study	Form of work-related violence	Sample size	Survey	Survey characteristics	Year data collected	Female %	Rate of violence (per 10,000 workers)
Biddle & Hartley (2002) United States	Homicide	14,000	National Traumatic Occupational Fatalities surveillance system	Annual NIOSH census that collects death certificates from the 50 States, New York City, and the District of Columbia for decedents 16 years of age or older.	1990-1997	19.9%	-
Budd (1999) England & Wales	Assaults or threats	7,410	British Crime Survey	National survey of people aged 16 and over about their experiences of crime in the last 12 months.	1998	47.3%	2800
Foley & Rausser (2012) Washington State, United States	Kicked, striking, beating, biting, shooting, or assault and violent acts	21,849	Washington State Department of Labor and Industries industrial insurance database	State insurance claims database	1997-2007	56.7%	13.5
Hartley et al. (2005) United States	Homicide	-	The Census of Fatal Occupational Injuries	National census of occupational injury fatalities	1992-2001	20.32%	0.07
Kaufert & Mattman (1998) United States	Fatalities, rapes, aggravated assaults, threats, or acts of harassment.	-	Statistics from Northwestern National Life, the Bureau of Justice Statistics, the Bureau of Labor Statistics, & the American Management Association.	Statistics from workers compensation, government and professional bodies.	1995	-	-
McCall & Horwitz (2004) United States	Assaults and violent acts, hitting, kicking, beating, shootings, squeezing, pinching, scratching, stabbing, threats, verbal assaults, biting or rape	2,028	Oregon Department of Consumer and Business Information and Management Division	State compensation administrative data	1990-1997	-	1.86
McGovern et al. (2000) Minnesota,	The act of causing physical injury or harm, including sexual assault	341	Minnesota Department of Labor and Industry Workers' Compensation	State workers' compensation database	1992	67%	1.84

United States			system				
Nelson & Kaufman (1996) Washington State, United States	Assaults and violent acts, hitting, kicking, beating, shootings, squeezing, pinching, scratching, stabbing, threats, verbal assaults, biting or rape	2,395	Washington State Workers' Compensation System	State insurance claims database	1992	57.7%	19
ODCBS (1996) Oregon, United States	Being struck, stabbed, beaten, shot, assaulted, bitten, and occupational mental stress where the source is another person.	1938	Oregon Workers' Compensation System	State insurance claims database	1991-1995	56.9%	3.3
Speroni et al. (2014) United States	Violence or the threat of violence against workers	30	Hospital health department database	Hospital system in Virginia, United States	2010	94.1%	59.8

Table 5 : Types of sub-costs included in cost estimation

	<u>Direct Costs</u>		<u>Indirect Costs</u>		<u>Intangible Costs</u>
	Healthcare	Non-healthcare	Productivity-related	Non-productivity	
Biddle (2002)	Medical		Early death		
Budd (1999)					Upset and inconvenience suffered
Foley & Rausser (2012)	Medical		Sickness absence (≥ 4 days)		
Hartley et al. (2005)	Medical		Early death	household production losses (includes activities such as child care and housework)	
McGovern et al. (2000)	Physician & nursing services, hospital charges, drug costs, rehabilitation services, ambulance fees, and payments for medical equipment & supplies (29.9%)	Legal (1.3%); Administrative (8.1%); Other expenses (0.2%); Compensation (5.1%)	Loss earnings (≥ 4 days) (31.2%)	Fringes (9.6%); Household chores (14.7%)	
McCall & Horwitz (2004)	Medical (50.96%)	Vocational rehabilitation (1.27%); Partial permanent disability benefits (20.14%)	Sickness absence (≥ 3 days) (27.62%)		
Nelson & Kaufman (1996)	Medical		Sickness absence (≥ 4 days)		
ODCBS (1996)	Medical (Fatal; 8.45%)	Indemnity(Fatal; 91.55%)			
	Medical (Non-Fatal; 57.36%)	Partial permanent disability benefits (Non-Fatal; 13.46%)	Sickness absence (Non-Fatal; ≥ 3 days) (29.19%)		
Speroni et al. (2014)	Medical (25.68%)	Indemnity(74.32%)			

Note. Percentage figures in parentheses denotes the proportion that cost type makes up within that study; Kaufer and Mattman (1998) did not specify their cost categories and are not included in this table.

Figure 1. A conceptual model mapping the human, organisational and economic costs of work-related violence

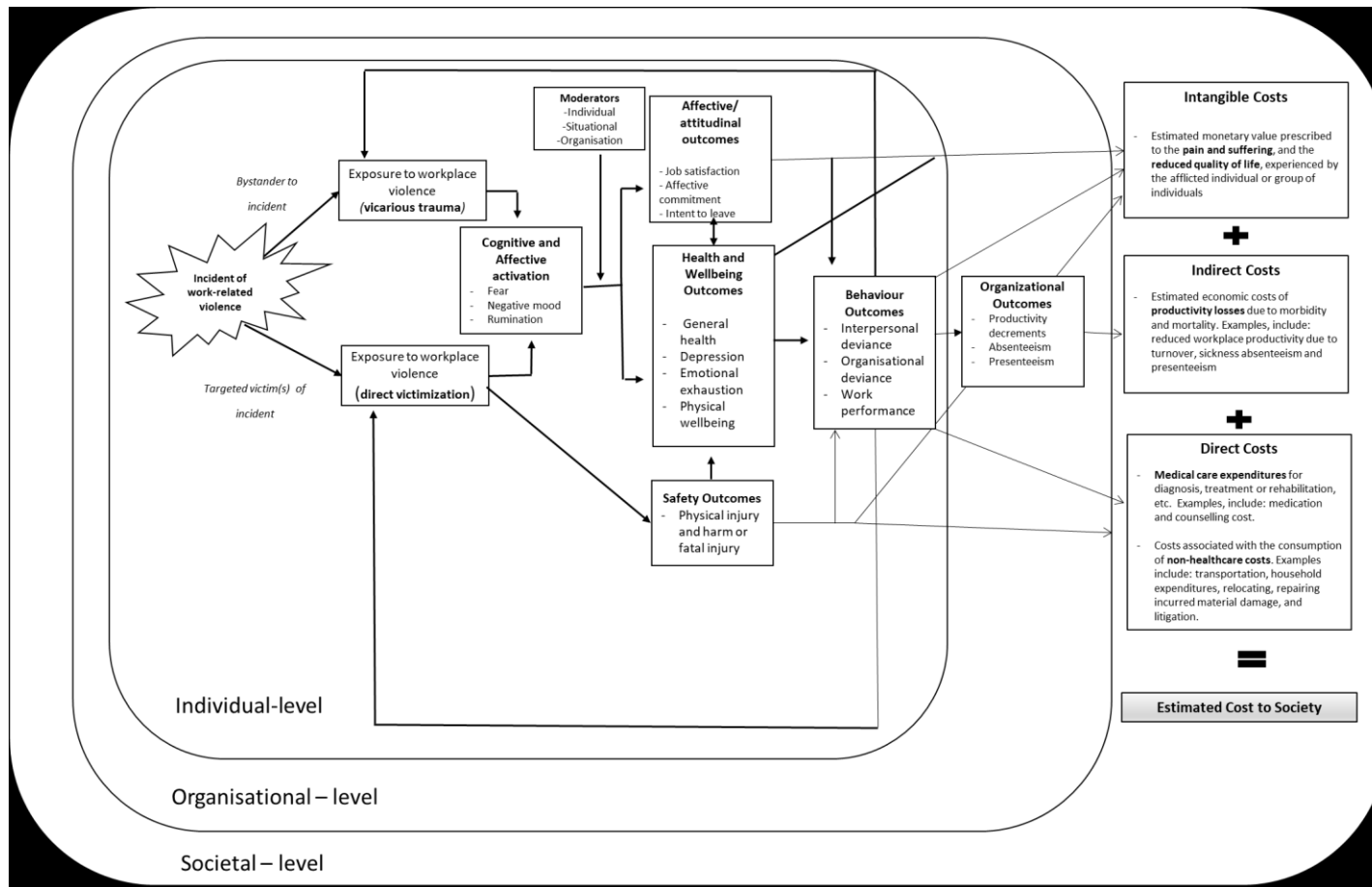


Figure 2. The review process based on PRISMA flow diagram

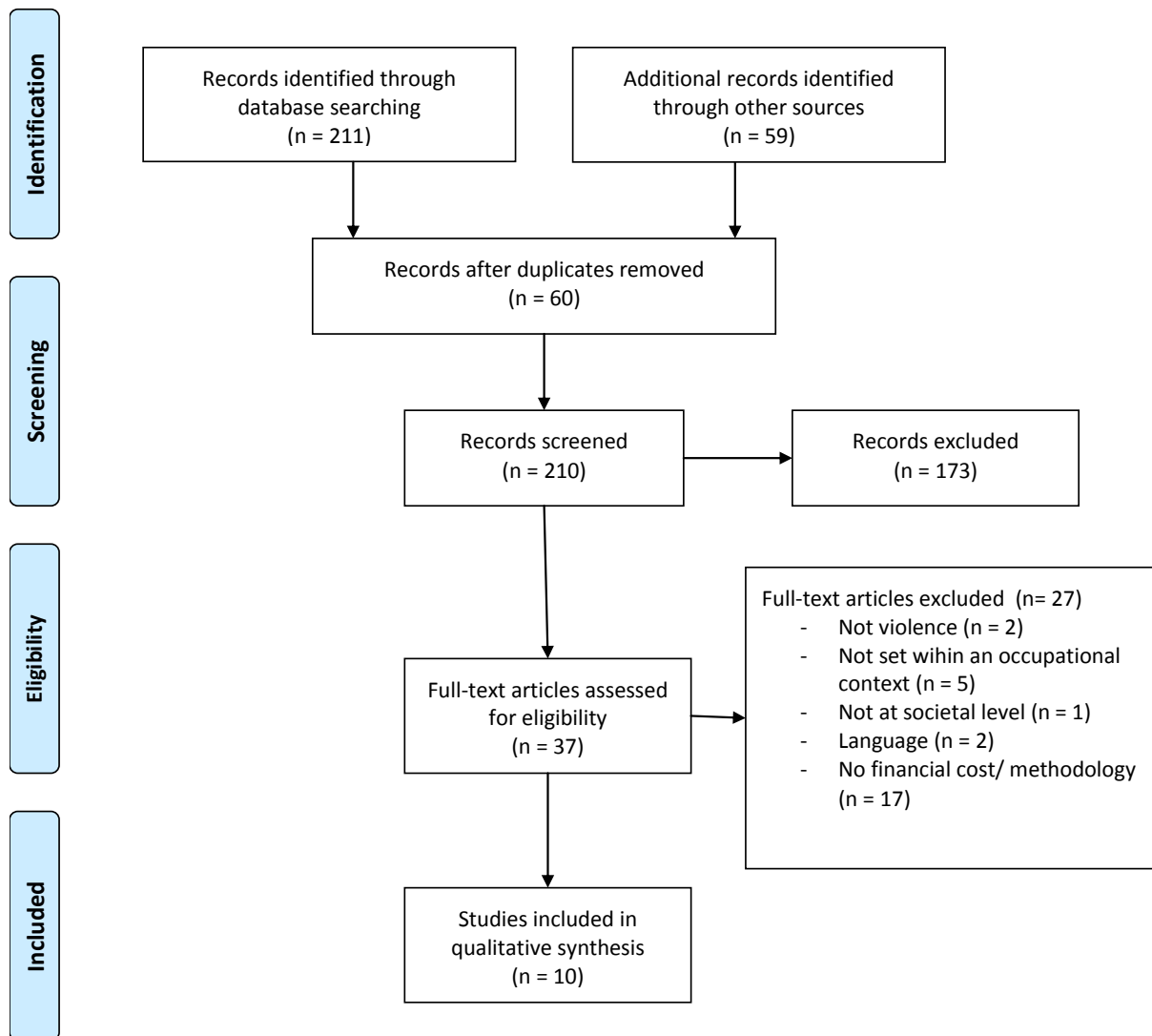


Figure 3. The proportion of the direct (healthcare, non-healthcare) and indirect (productivity loss, non-productivity loss) costs of work-related violence

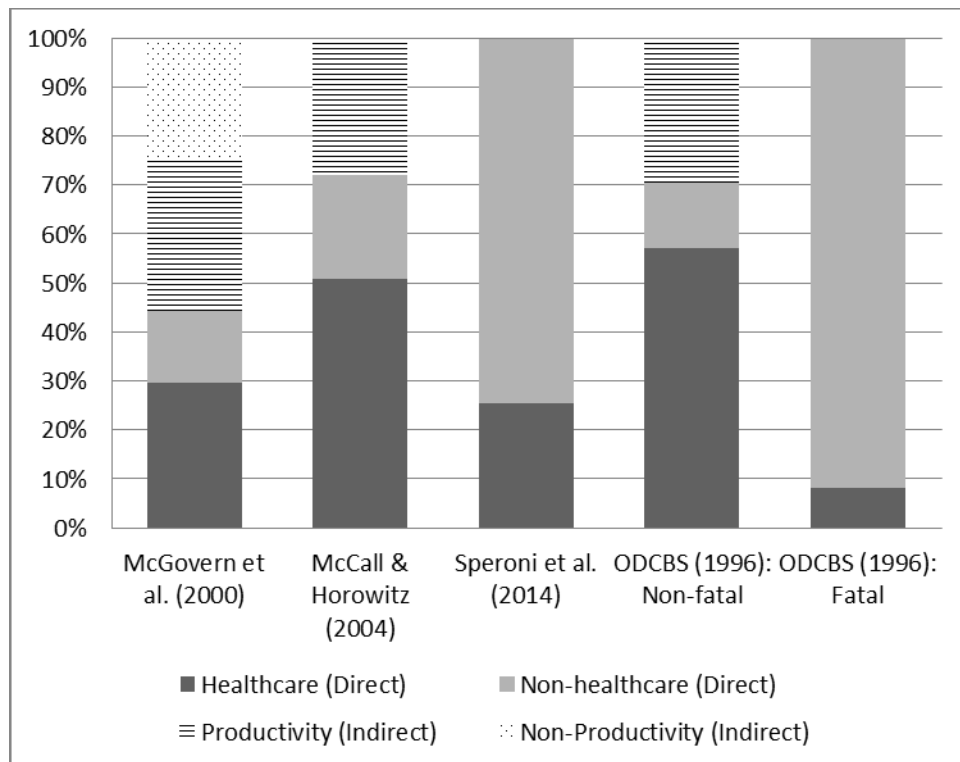


Figure 4. An iceberg model of the cost of work-related violence to society

