Environment International 120 (2018) 22–33

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Review article

# WHO/ILO work-related burden of disease and injury: Protocol for systematic reviews of exposure to long working hours and of the effect of exposure to long working hours on alcohol consumption and alcohol use disorders

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## ABSTRACT

*Background:* The World Health Organization (WHO) and the International Labour Organization (ILO) are developing a joint methodology for estimating the national and global work-related burden of disease and injury (WHO/ILO joint methodology), with contributions from a large network of experts. In this paper, we present the protocol for two systematic reviews of parameters for estimating the number of deaths and disability-adjusted life years from alcohol consumption and alcohol use disorder attributable to exposure to long working hours, to inform the development of the WHO/ILO joint methodology.

*Objectives:* We aim to systematically review studies on exposure to long working hours (Systematic Review 1) and systematically review and meta-analyse estimates of the effect of exposure to long working hours on alcohol consumption and alcohol use disorder (Systematic Review 2), applying the *Navigation Guide* systematic review methodology as an organizing framework.

*Data sources:* Separately for Systematic Reviews 1 and 2, we will search electronic academic databases for potentially relevant records from published and unpublished studies, including MEDLINE, Embase, Web of Science, CISDOC and PsychINFO. We will also search electronic grey literature databases, Internet search engines and organizational websites; hand-search reference list of previous systematic reviews and included study records; and consult additional experts.

*Study eligibility and criteria:* We will include working-age (≥15 years) workers in the formal and informal economy in any WHO and/or ILO Member State but exclude children (< 15 years) and unpaid domestic workers. For Systematic Review 1, we will include quantitative prevalence studies of relevant levels of exposure to long working hours (i.e., 35–40, 41–48, 49–54 and ≥55 h/week) stratified by country, sex, age and industrial sector or occupation. For Systematic Review 2, we will include randomized controlled trials, cohort studies, case-control studies and other non-randomized intervention studies with an estimate of the relative effect of a relevant level of exposure to long working hours on total amount of alcohol consumed and on the incidence of, prevalence of or mortality from alcohol use disorders, compared with the theoretical minimum risk exposure level (i.e., worked 35–40 h/week).

*Study appraisal and synthesis methods:* At least two review authors will independently screen titles and abstracts at a first stage and full texts of potentially eligible records at a second stage, followed by extraction of data from qualifying studies. At least two review authors will assess risk of bias and quality of evidence, using the most suited tools currently available. For Systematic Review 2, if feasible, we will combine relative risks using meta-analysis. We will report results using the guidelines for accurate and transparent health estimates reporting (GATHER) for Systematic Review 1 and the preferred reporting items for systematic reviews and

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https://doi.org/10.1016/j.envint.2018.07.025
Received 4 January 2018; Received in revised form 6 July 2018; Accepted 16 July 2018

meta-analyses guidelines (PRISMA) for Systematic Review 2.

*PROSPERO registration number*: CRD42018084077.

## 1. Background

The World Health Organization (WHO) and the International Labour Organization (ILO) are developing a joint methodology for estimating the work-related burden of disease and injury (WHO/ILO joint methodology) (Ryder, 2017). The organizations plan to estimate in the future the numbers of deaths and disability-adjusted life years (DALYs) that are attributable to selected occupational risk factors, for the year 2015. The WHO/ILO joint methodology will be based on already existing WHO and ILO methodologies for estimating the burden of disease for selected occupational risk factors (International Labour Organization, 2014; Pruss-Ustun et al., 2017). It will expand existing methodologies with estimation of the burden of several prioritized additional pairs of occupational risk factors and health outcomes. For this purpose, population attributable fractions (Murray et al., 2004) – the proportional reduction in burden from the health outcome achieved by a reduction of exposure to the theoretical minimum risk exposure level – will be calculated for each additional risk factor-outcome pair, and these fractions will be applied to the total disease burden envelopes for the health outcome from the WHO *Global Health Estimates* (World Health Organization, 2017).

The WHO/ILO joint methodology may include a methodology for estimating the burden of alcohol consumption from exposure to long working hours if feasible, as one additional prioritized risk factor-outcome pair. To optimize parameters used in estimation models, a systematic review of studies on the prevalence of occupational exposure to the risk factor ('Systematic Review 1') is required, as well as a second systematic review and meta-analysis of studies with estimates of the effect of exposure to long working hours on alcohol consumption and on the incidence of, prevalence of or mortality from alcohol use disorders ('Systematic Review 2'). In the current paper, we present the protocol for these two systematic reviews, in parallel to presenting systematic review protocols on other additional risk factor-outcome pairs elsewhere (Descatha et al., in press; Hulshof et al., under review; John et al., under review; Li et al., accepted; Mandrioli et al., in press; Rugulies et al., under review; Teixeira et al., under review; Tenkate et al., under review). To our knowledge, this is the first protocol of its kind. The WHO/ILO joint estimation methodology and the burden of disease estimates are separate from these systematic reviews, and they will be described and reported elsewhere.

We refer separately to Systematic Reviews 1 and 2, because the two Systematic Reviews address two different objectives and therefore require different methodologies. However, the two Systematic Reviews will be conducted in tandem and in a harmonized way. This harmonization will ensure that – in the later development of the methodology for estimating the burden of disease from the risk factor-outcome pair – the parameters from included studies on the risk factor are optimally matched with the parameters from studies on the effect of the risk factor on the outcome. The findings from Systematic Reviews 1 and 2 will be reported in two separate journal articles. For the four protocols with long working hours as the risk factor in the series (Descatha et al., in press; Li et al., accepted; Rugulies et al., under review), one Systematic Review 1 will be published jointly.

### 1.1. Rationale

To consider the feasibility of estimating the burden of alcohol consumption from long working hours in adherence with the guidelines for accurate and transparent health estimates reporting (GATHER) (Stevens et al., 2016), WHO and ILO require a systematic review of studies on the prevalence of relevant levels of exposure to long working hours (Systematic Review 1), as well as a systematic review and meta-analysis of studies with estimates of the relative effect of long working hours on alcohol consumption, compared with the theoretical minimum risk exposure level (Systematic Review 2). The theoretical minimum risk exposure level is the exposure level that would result in the lowest possible population risk, even if it is not feasible to attain this exposure level in practice (Murray et al., 2004). These data and effect estimates should be tailored to serve in the future as parameters for estimating the burden of alcohol consumption and alcohol use disorders from long working hours in the WHO/ILO joint methodology.

A previous systematic review of individual participant data and cross-sectional and prospective studies has shown that people working long hours are more likely to use alcohol at harmful levels (odds ratio 1.11, 95% confidence interval 1.05 to 1.18) (Virtanen et al., 2015). However, this systematic review included study designs that are not acceptable for burden of disease estimation (e.g., cross-sectional studies). We are aware of previous systematic reviews neither of exposure to long working hours, nor specifically for burden of disease estimation.

Work in the informal economy may lead to different exposures and exposure effects than does work in the formal economy. The informal economy is defined as "all economic activities by workers and economic units that are – in law or in practice – not covered or insufficiently covered by formal arrangements", but excluding "illicit activities, in particular the provision of services or the production, sale, possession or use of goods forbidden by law, including the illicit production and trafficking of drugs, the illicit manufacturing of and trafficking in firearms, trafficking in persons, and money laundering, as defined in the relevant international treaties" (p. 4) (104th International Labour Conference, 2015). Consequently, formality of work (informal vs. formal) may be an effect modifier of the effect of long working hours on alcohol consumption and alcohol use disorders. Therefore, we will consider the formal and informal economy studied in studies included in both Systematic Reviews of this research.

### 1.2. Description of the risk factor

The definition of the risk factor, the risk factor levels and the theoretical minimum risk exposure level are presented in Table 1. Long working hours are defined as any working hours exceeding standard

**Table 1**
Definitions of the risk factor, risk factor levels and the minimum risk exposure level.

| | |
|---|---|
| Risk factor | Long working hours, defined as working hours > 40/week hours, i.e. working hours exceeding standard working hours that are defined as 35–40 h/week |
| Risk factor levels | Preferable exposure categories are 41–48 h/week, 49–54 h/week and ≥ 55 h/week. However, whether we can use these categories will depend on the information provided in the studies. If the preferable exposure categories are not available, we will use the exposure categories provided by the studies, as long these exposure categories exceed 40 h/week. |
| Theoretical minimum risk exposure level | Standard working hours defined as working hours of 35–40 h/week |

working hours, i.e. working hours of > 40 h/week. Based on results from earlier studies on long working hours and health endpoints (Kivimäki et al., 2015a; Kivimäki et al., 2015b; Virtanen et al., 2015), the preferred four exposure level categories for our review are 35–40, 41–48, 49–54 and ≥55 h/week. This will allow calculating estimates both for large exposure contrast (i.e. comparing the theoretical minimal exposure to ≥55 h) and for dose-response associations (i.e. comparing the theoretical minimal exposure to all other exposure categories). If the studies provide the preferred exposure level categories, we will use the preferred exposure categories, if they provide other exposure categories; we will use the other exposure categories, as long as exposure exceeds 40 h/week.

The theoretical minimum risk exposure (the reference group) is standard working hours defined as 35–40 h worked per week. We acknowledge that it is possible that the theoretical minimum risk exposure might be lower than standard working hours, however we have to exclude working hours of < 35 h/week, because studies indicate that a proportion of people working less than standard hours do so because of existing health problems (Kivimäki et al., 2015a; Virtanen et al., 2012). Thus, this exposure concerns full-time workers in the formal and informal economy. In other words, people working less than standard hours might belong to a health-selected group or a group concerned with family care and therefore cannot serve as comparators. Consequently, if a study included people working less than standard hours as the reference group, or combines people working standard hours and people working less than standard hours as the reference group, then these studies will be excluded from the review and meta-analysis. Since the theoretical minimum risk exposure level is usually set empirically based on the causal epidemiological evidence, we will change the level we currently assume, should the evidence suggests another level.

If a considerable number of studies report risk factor levels or reference group levels that are different from those definitions we describe here, then, if possible, we will convert the studies to common measures and, if not possible, we will report analyses on these alternate levels as supplementary information. In this case, our protocol will be updated to reflect new analyses.

### 1.3. Description of outcomes

The WHO *Global Health Estimates* group outcomes into standard burden of disease categories (World Health Organization, 2017), based on standard codes from the *International Statistical Classification of Diseases and Related Health Problems 10th Revision* (ICD-10) (World Health Organization, 2015). The first outcome of Systematic Review 2 is alcohol consumption, defined as absolute measures of total alcohol consumption in grams of alcohol/week, as an intermediate outcome for alcohol use disorders or potentially other disease burden categories. Whenever number of “drinks” is reported, we will calculate the total amount of alcohol consumed in grams, assuming that one “drink” corresponds to 12 g of pure alcohol. We will therefore apply the European Standards (10–12 g of alcohol per standard drink), but we acknowledge that this choice is somehow arbitrary and that it may underestimate alcohol consumption for countries, in which a standard drink contains more than12 g of alcohol.

The second outcome of Systematic Review 2 is alcohol use disorders. The relevant WHO *Global Health Estimates* category is *II.E.4 Alcohol use disorders* (ICD-10 codes: F10, G72.1, Q86.0, ×45) (World Health Organization, 2017). Table 2 presents each disease or health problem included in the WHO *Global Health Estimates* category and whether it is included in this review. This systematic review covers the entire disease burden of the relevant WHO *Global Health Estimates* category. Studies focusing on other alcohol-related disorders not covered in the burden of disease envelope related to alcohol-induced disorders will not be included in this systematic review, to align with the WHO/ILO joint methodology.

### 1.4. How the risk factor may impact the outcome

Official health estimates of the burden of disease attributable to an occupational risk factor require a sufficient level of scientific consensus that the risk factor causes the disease or other outcome (Stevens et al., 2016). A possible explanation for the association between exposure to long working hours and alcohol consumption and alcohol use disorders, respectively, is that exposure to long working hours may cause stress, and alcohol consumption may be a coping mechanism for this stress, as proposed by the tension-reduction hypothesis (Kalodner et al., 1989). However, we acknowledge that stress is a multidimensional and dynamic concept.

Fig. 1 presents the logic model for the causal relationship between exposure to long working hours and alcohol consumption and alcohol use disorders, respectively. This is an a priori, process-oriented model (Rehfuess et al., 2018) that seeks to capture the complexity of the causal relationship between exposure to long working hours and alcohol consumption and alcohol use disorders, respectively (Anderson et al., 2011). We assume that the effect of exposure to long working hours on alcohol consumption and alcohol use disorders could be modified by country, age, sex, socioeconomic position, industrial sector, occupation and formality of economy. Confounding effects should be considered by age, sex and socioeconomic position (e.g. income, education or occupational grade). We also assume that the effects of long working hours on alcohol consumption and alcohol use disorders are mediated through two pathways, namely work-related stress imposed by long working hours and individual coping strategies, herein defined as the individual worker's ability to deal with stress and anxiety derived from job demands and especially long working hours (Barnes et al., 2014; Bartone et al., 2017; Corbin et al., 2013; Park et al., 2004). Therefore, these two variables will be considered to be mediators.

Rodent models also support a causal effect of external stress on alcohol consumption. Interactions between stress and the reward system seem to induce alcohol consumption, especially in alcohol-experienced people. Glucocorticoids effects within the nucleus accubems, which plays an important role in the cognitive processing of motivation and reward, are likely mediators in this relationship. An increased activation of the corticotrophin-releasing hormone (CRH) within the amigdala has been also implicated. After they have been exposed to different types of stressors, rats increase alcohol consumption with a delay that parallels the one observed in humans relapsing to heavy alcohol use after a stressful period. This body of evidence is related to stress rather than to long working hours per se, and, therefore, it should be regarded only as indirect evidence of a causal relationship between exposure with long working hours and alcohol consumption, and perhaps also with alcohol use disorder (Liu and Weiss, 2003; Noori et al., 2014; Spanagel et al., 2014).

## 2. Objectives

1. Systematic Review 1: To systematically review quantitative studies of any design on the prevalence of different levels of exposure to long working hours in the years 2005 to 2018 among the working-

**Table 2**
ICD-10 codes and disease and health problems covered by the WHO burden of disease category II.E.4 Alcohol use disorders and their inclusion in this review.

| ICD-10 Code | Disease or health problem | Included in this review |
|---|---|---|
| F10 | Mental and behavioural disorders due to use of alcohol | Yes |
| G72.1 | Alcoholic myopathy | Yes |
| Q86.0 | Fetal alcohol syndrome (dysmorphic) | Yes |
| ×45 | Accidental poisoning by and exposure to alcohol | Yes |

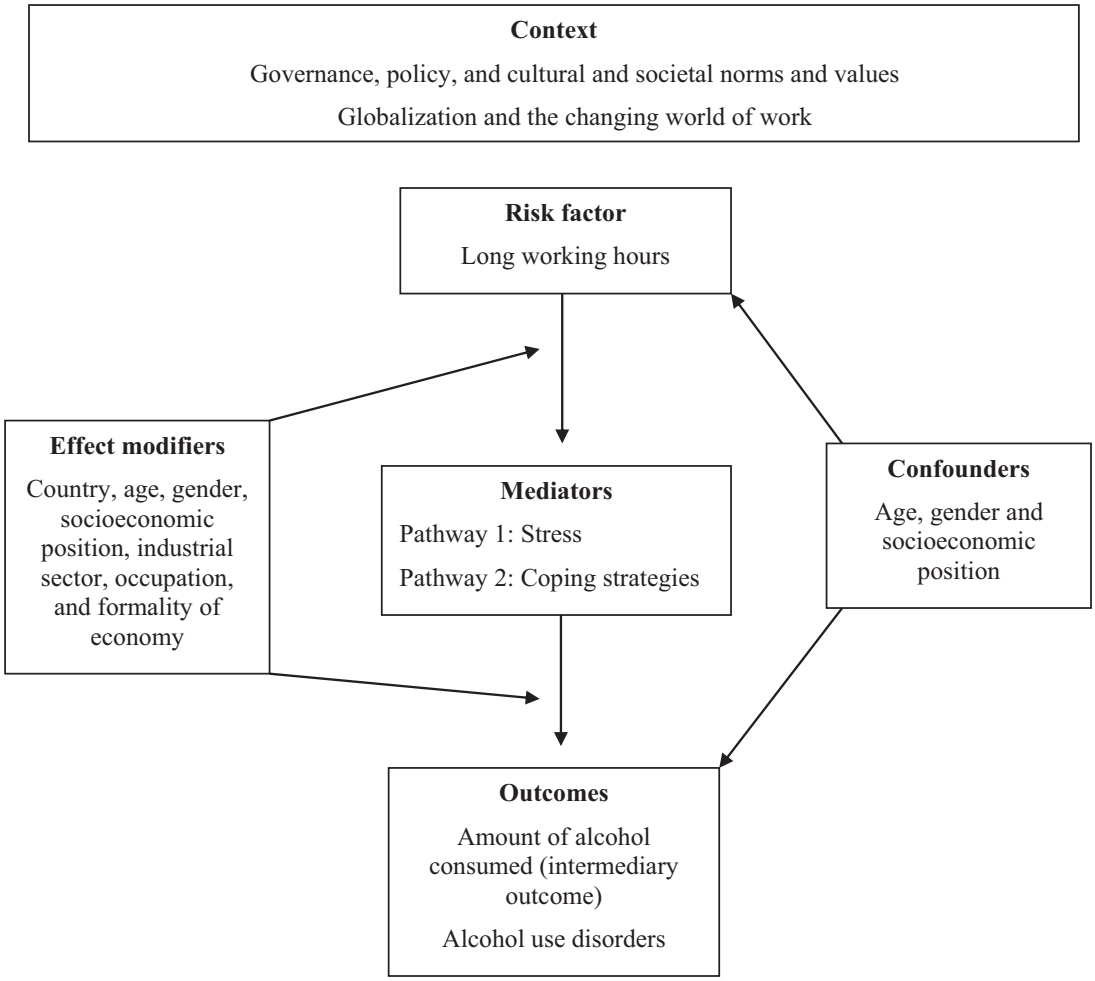


**Fig. 1.** Logic model of the potential causal relationship between long working hours and alcohol consumption and alcohol use disorders.

age population, disaggregated by country, sex, age and industrial sector or occupation. Systematic Review 1 will be conducted in a coordinated fashion across all four review groups that examine the relationship between long working hours and certain health endpoints (ischemic heart disease (Li et al., accepted), stroke (Descatha et al., in press), depression (Rugulies et al., under review) and alcohol consumption).

2. Systematic Review 2: To systematically review and meta-analyse randomized controlled studies, cohort studies, case-control studies and other non-randomized intervention studies with estimates of the relative effect of a relevant level of exposure to long working hours on total alcohol consumption (outcome 1) and on the prevalence of, incidence of or mortality from alcohol use disorders (outcome 2), respectively, among the working age population, compared with those with the minimum risk exposure level of 35–40 h/week.

## 3. Methods

We will apply the *Navigation Guide* (Woodruff and Sutton, 2014) systematic review methodology for systematic reviews in occupational and environmental health as our guiding methodological framework, wherever feasible. The guide applies established systematic review methods from clinical medicine, including standard Cochrane Collaboration methods for systematic reviews of interventions, to the field of occupational and environmental health to ensure systematic and rigorous evidence synthesis on occupational and environmental risk factors that reduces bias and maximizes transparency (Woodruff and Sutton, 2014). The need for further methodological development and refinement of the relatively novel *Navigation Guide* has been acknowledged (Woodruff and Sutton, 2014).

Systematic Review 1 may not map well to the *Navigation Guide* framework (Fig. 1 on page 1009 in (Lam et al., 2016c)), which is tailored to hazard identification and risk assessment. Nevertheless, steps 1–6 for the stream on human data can be applied to systematically review exposure to risk factors. Systematic Review 2 maps more closely to the *Navigation Guide* framework, and we will conduct steps 1–6 for the stream on human data, but not conduct any steps for the stream on non-human data, although we will briefly summarize narratively the evidence from non-human data that we are aware of.

We have registered the protocol in PROSPERO under CRD42018084131. This protocol adheres with the preferred reporting items for systematic review and meta-analysis protocols statement (PRISMA-P) (Moher et al., 2015; Shamseer et al., 2015), with the abstract adhering with the reporting items for systematic reviews in journal and conference abstracts (PRISMA-A) (Beller et al., 2013). Any modification of the methods stated in the present protocol will be registered in PROSPERO and reported in the systematic review itself. Systematic Review 1 will be reported according to the GATHER guidelines (Stevens et al., 2016), and Systematic Review 2 will be reported according to the preferred reporting items for systematic review and meta-analysis statement (PRISMA) (Liberati et al., 2009). Our reporting of all parameters for estimating the burden of pneumoconiosis from occupational exposure to dusts and/or fibres in the systematic review will adhere with the requirements of the GATHER guidelines

(Stevens et al., 2016), because the WHO/ILO burden of disease estimates that may be produced consecutive to the systematic review must also adhere to these reporting guidelines.

### 3.1. Systematic review 1

#### 3.1.1. Eligibility criteria

The population, exposure, comparator and outcome (PECO) criteria (Liberati et al., 2009) are described below.

*3.1.1.1. Types of populations*. We will include studies of working-age (≥15 years) workers in the formal and informal economy. Studies of children (aged <15 years) and unpaid domestic workers will be excluded. Participants residing in any WHO and/or ILO Member State and workers in any industrial setting and occupation will be included. We note that exposure to long working hours may potentially have further population reach (e.g. across generations for workers of reproductive age) and acknowledge that the scope of our systematic reviews will not be able capture these populations and impacts on them. Appendix A provides a complete, but briefer overview of the PECO criteria.

*3.1.1.2. Types of exposures*. We will include studies that define long working hours in accordance with our standard definition (Table 1). We will prioritize measures of the total number of hours worked, including in both of: main and secondary jobs, self-employment and salaried employment and informal and formal jobs. Cumulative exposure may be the most relevant exposure metric in theory, but we will here also prioritize a non-cumulative exposure metric in practice, because we believe that global exposure data on agreed cumulative exposure measures do not currently exist. We will include all studies where long working hours were measured, whether objectively (e.g. by means of time recording technology), or subjectively, including studies that used measurements by experts (e.g. scientists with subject matter expertise) and self-reports by the worker or workplace administrator or manager. If a study presents both objective and subjective measurements, then we will prioritize objective measurements. We will include studies with measures from any data source, including registry data, in the same analyses and description.

We will include studies on the prevalence of occupational exposure to the risk factor, if it is disaggregated by country, sex (two categories: female, male), age group (ideally in 5-year age bands, such as 20–24 years) and industrial sector (e.g. *International Standard Industrial Classification of All Economic Activities, Revision 4* [ISIC Rev. 4]) (United Nations, 2008) or occupation (as defined, for example, by the *International Standard Classification of Occupations 1988* [ISCO-88] (International Labour Organization, 1987) or *2008* [ISCO-08] (International Labour Organization, 2012)). We will also extract data on the context of risk factor exposure. Criteria may be revised in order to identify optimal data disaggregation to enable subsequent estimation of the burden of disease.

We shall include studies with exposure data for the years 2005 to 30 June 2018. For optimal modelling of exposure, WHO and ILO require exposure data up to 2018, because recent data points help better estimate time trends, especially where data points may be sparse. The additional rationale for this data collection window is that the WHO and ILO aim to estimate burden of disease in the year 2015, and we believe that the lag time from exposure to outcome will not exceed 10 years; so in their models, the organizations can use the exposure data from as early as 2005 to determine the burden of alcohol consumption and alcohol use disorder 10 years later in 2015. To make a conclusive judgment on the best lag time to apply in the model, we will summarize the existing body of evidence on the lag time between exposure to long working hours and alcohol consumption and alcohol use disorder, respectively, in the review.

Both objective and subjective measures will be included. If both subjective and objective measures are presented, then we will prioritize objective ones. Studies with measures from any data source, including registries, will be eligible. The exposure parameter should match the one used in Systematic Review 2 or can be converted to match it.

*3.1.1.3. Types of comparators*. There will be no comparator, because we will review risk factor prevalence only.

*3.1.1.4. Types of outcomes*. Exposure to the occupational risk factor (i.e. long working hours).

*3.1.1.5. Types of studies*. This Systematic Review will include quantitative studies of any design, including cross-sectional studies. These studies must be representative of the relevant industrial sector, relevant occupational group or the national population. We will exclude qualitative, modelling, and case studies, as well as non-original studies without quantitative data (e.g. letters, commentaries and perspectives).

Study records written in any language will be included. If a study record is written in a language other than those spoken by the authors of this review or those of other reviews (Descatha et al., in press; Hulshof et al., under review; John et al., under review; Li et al., accepted; Mandrioli et al., in press; Rugulies et al., under review; Teixeira et al., under review; Tenkate et al., under review) in the series (i.e. Arabic, Bulgarian, Chinese, Danish, Dutch, English, French, Finnish, German, Hungarian, Italian, Japanese, Norwegian, Portuguese, Russian, Spanish and Swedish), it will be translated into English. Published and unpublished studies will be included.

Studies conducted using unethical practices will be excluded from the review.

*3.1.1.6. Types of effect measures*. We will include studies with a measure of the prevalence of a relevant level of exposure to long working hours.

#### 3.1.2. Information sources and search

We will search for potentially eligible records in electronic academic and grey literature databases, Internet search engines and organizational websites. Several hand-searches of records and journals will also be conducted, and experts will be consulted.

*3.1.2.1. Electronic academic databases*. We (DG, JP and GS) will at a minimum search the following seven electronic academic databases:

1. Ovid Medline with Daily Update (2005 to 30 June 2018).
2. PubMed (2005 to 30 June 2018).
3. EMBASE (2005 to 30 June 2018).
4. Scopus (2005 to 30 June 2018).
5. Web of Science (2005 to 30 June 2018).
6. CISDOC (2005 to 30 June 2012).
7. PsychInfo (2005 to 30 June 2018).

The Ovid Medline search strategy for Systematic Review 1 is presented in Appendix B. We will perform searches in electronic databases operated in the English language using a search strategy in the English language. Consequently, study records that do not report essential information (i.e. title and abstract) in English will not be captured. We will adapt the search syntax to suit the other electronic academic and grey literature databases. When we are nearing completion of the review, we will search the PubMed database for the most recent publications (e.g., e-publications ahead of print) over the last six months. Any deviation from the proposed search strategy in the actual search strategy will be documented.

*3.1.2.2. Electronic grey literature databases*. AD, DG, JP, and GS will at a minimum search the two following electronic academic databases:

1. OpenGrey (http://www.opengrey.eu/)
2. Grey Literature Report (http://greylit.org/)

*3.1.2.3. Internet search engines*. We (AD, DG, JP and GS) will also search the Google (www.google.com/) and GoogleScholar (www.google.com/scholar/) Internet search engines and screen the first 100 hits for potentially relevant records.

*3.1.2.4. Organizational websites*. The websites of the following six international organizations and national government departments will be searched by AD, DG, JP and GS:

1. International Labour Organization (www.ilo.org/).
2. World Health Organization (www.who.int).
3. European Agency for Safety and Health at Work (https://osha.europa.eu/en).
4. Eurostat (www.ec.europa.eu/eurostat/web/main/home).
5. China National Knowledge Infrastructure (http://www.cnki.net/).
6. Finnish Institute of Occupational Health (https://www.ttl.fi/en/).
7. United States National Institute of Occupational Safety and Health (NIOSH) of the United States of America, using the NIOSH data and statistics gateway (https://www.cdc.gov/niosh/data/).

*3.1.2.5. Hand-searching and expert consultation*. AD, DG, JP, and GS will hand-search for potentially eligible studies in:

- Reference list of previous systematic reviews.
- Reference list of all study records of all included studies.
- Study records published over the past 24 months in the three peer-reviewed academic journals from which we obtain the largest number of included studies.
- Study records that have cited an included study record (identified in Web of Science citation database).
- Collections of the review authors.

Additional experts will be contacted with a list of included studies and study records, with the request to identify potentially eligible additional ones.

### 3.1.3. Study selection

Study selection will be carried out with Covidence (Babineau, 2014; Covidence systematic review software) and/or the Rayyan Systematic Reviews Web App (Ouzzani et al., 2016). All study records identified in the search will be downloaded and duplicates will be identified and deleted. Afterwards, at least two review authors (out of: BAE, DG, JP and ES), working in pairs, will independently screen against eligibility criteria titles and abstracts (step 1) and then full texts of potentially relevant records (step 2). A third review author (AD, LM or GS) will resolve any disagreements between the pairs of study selectors. If a study record identified in the literature search was authored by a review author assigned to study selection or if an assigned review author was involved in the study, then the record will be re-assigned to another review author for study selection. In the systematic review, we will document the study selection in a flow chart, as per GATHER guidelines (Stevens et al., 2016).

### 3.1.4. Data extraction and data items

A data extraction form will be developed and piloted until there is convergence and agreement among data extractors. At a minimum, two review authors (out of: BAE, ES and LMH) will independently extract the data on exposure to long working hours, disaggregated by country, sex, age and industrial sector or occupation. A third review author (GS) will resolve conflicting extractions. At a minimum, we will extract data on study characteristics (including study authors, study year, study country, participants, exposure and outcome), study design (including study type and measurements of the risk factor and outcome, and response rate), risk of bias (including missing data, as indicated by response rate and other measures) and study context. The estimates of the proportion of the population exposed to the occupational risk factor from included studies will be entered into and managed with, the Review Manager, Version 5.3 (RevMan 5.3) (2014) or DistillerSR (EvidencePartner, 2017) softwares.

We will also extract data on potential conflict of interest in included studies, including the financial disclosures and funding sources of each author and their affiliated organization. We will use a modification of a previous method to identify and assess undisclosed financial interests (Forsyth et al., 2014). Where no financial disclosure/conflict of interest is provided, we will search declarations of interest both in other records from this study published in the 36 months prior to the included study record and in other publicly available repositories (Drazen et al., 2010a; Drazen et al., 2010b).

We will request missing data from the principal study author by email or phone, using the contact details provided in the principal study record. If no response is received, we will follow up twice via email, at two and four weeks.

### 3.1.5. Risk of bias assessment

Generally agreed methods (i.e. framework plus tool) for assessing risk of bias do not exist for systematic reviews of input data for health estimates (The GATHER Working Group, 2016), for burden of disease studies, of prevalence studies in general (Munn et al., 2014), and those of prevalence studies of occupational and/or environmental risk factors specifically (Krauth et al., 2013; Mandrioli and Silbergeld, 2016; Vandenberg et al., 2016). None of the five standard risk of bias assessment methods in systematic reviews (Rooney et al., 2016) is applicable to assessing prevalence studies. The *Navigation Guide* does not support checklist approaches, such as (Hoy et al., 2012; Munn et al., 2014), for assessing risk of bias in prevalence studies.

We will use a modified version of the *Navigation Guide* risk of bias tool (Lam et al., 2016c) that we developed specifically for Systematic Review 1 (Appendix C). We will assess risk of bias on the levels of the individual study and the entire body of evidence. As per our preliminary tool, we will assess risk of bias along five domains: (i) selection bias; (ii) performance bias; (iii) misclassification bias; (iv) conflict of interest; and (v) other biases. Risk of bias will be: “low”; “probably low”; “probably high”; “high” or “not applicable”. To judge the risk of bias in each domain, we will apply our a priori instructions (Appendix C).

All risk of bias assessors (BE, DG, ES, LM and GS) will trial the tool until they synchronize their understanding and application of each risk of bias domain, considerations and criteria for ratings. At least two study authors (out of: BE, DG, ES, and LM) will then independently judge the risk of bias for each study by outcome, and a third author (GS) will resolve any conflicting judgments. We will present the findings of our risk of bias assessment for each eligible study in a standard ‘Risk of bias’ table (Higgins et al., 2011). Our risk of bias assessment for the entire body of evidence will be presented in a standard ‘Risk of bias summary’ figure (Higgins et al., 2011).

### 3.1.6. Synthesis of results

We will neither produce any summary measures, nor synthesise the evidence quantitatively. The included evidence will be presented in what could be described as an ‘evidence map’. All included data points from included studies will be presented, together with meta-data on the study design, number of participants, characteristics of population, setting, and exposure measurement of the data point.

### 3.1.7. Quality of evidence assessment

There is no agreed method for assessing quality of evidence in systematic reviews of the prevalence of occupational and/or environmental risk factors. We will adopt/adapt from the latest *Navigation Guide* instructions for grading (Lam et al., 2016c), including criteria

(Appendix D). We will downgrade for the following five reasons from the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach: (i) risk of bias; (ii) inconsistency; (iii) indirectness; (iv) imprecision; and (v) publication bias (Schünemann et al., 2011). We will grade the evidence, using the three *Navigation Guide* quality of evidence ratings: "high", "moderate" and "low" (Lam et al., 2016c). Within each of the relevant reasons for downgrading, we will rate any concern per reason as "none", "serious" or "very serious". We will start at "high" for non-randomized studies and will downgrade for no concern by nil, for a serious concern by one grade (−1), and for a very serious concern by two grades (−2). We will not up-grade or down-grade the quality of evidence for the three other reasons normally considered in GRADE assessments (i.e. large effect, dose-response and plausible residual confounding and bias), because we consider them irrelevant for prevalence estimates.

All quality of evidence assessors (BAE, ES, LMH and DG) will trial the application of our instructions and criteria for quality of evidence assessment until their understanding and application is synchronized. At least two review authors (ES and LMH) will independently judge the quality of evidence for the entire body of evidence by outcome. A third review author (GS) will resolve any conflicting judgments. In the systematic review, for each outcome, we will present our assessments of the risk for each GRADE domain, as well as an overall GRADE rating.

#### 3.1.8. Strength of evidence assessment

To our knowledge, no agreed method exists for rating strength of evidence in systematic reviews of prevalence studies. We (AD and GS) will rate the strength of the evidence for use as input data for estimating national-level exposure to the risk factor. Our rating will be based on a combination of the following four criteria: (i) quality of the entire body of evidence; (ii) population coverage of evidence (WHO regions and countries); (iii) confidence in the entire body of evidence; and (iv) other compelling attributes of the evidence that may influence certainty. We will rate the strength of the evidence as either "potentially sufficient" or "potentially inadequate" for use as input data (Appendix E).

### 3.2. Systematic review 2

#### 3.2.1. Eligibility criteria

The PECO (Liberati et al., 2009) criteria are described below.

*3.2.1.1. Types of populations*. We will include studies of the working-age (≥15 years) workers in the formal and informal economy. Studies of children (aged <15 years) and unpaid domestic workers will be excluded. Data on the formal and informal economy that the workers work in will be extracted. Participants residing in any WHO and/or ILO Member State and any industrial setting or occupational group will be included. We note that occupational exposure to long working hours may potentially have further population reach (e.g. across generations for workers of reproductive age) and acknowledge that the scope of our systematic reviews will not be able capture these populations and impacts on them. Appendix F provides a complete, but briefer overview of the PECO criteria.

*3.2.1.2. Types of exposures*. We will include studies that define long working hours in accordance with our standard definition (Table 1). We will again prioritize measures of the total number of hours worked, including in both of: main and secondary jobs, self-employment and salaried employment and informal and formal jobs. We will include all studies where long working hours were measured, whether objectively (e.g. by means of time recording technology), or subjectively, including studies that used measurements by experts (e.g. scientists with subject matter expertise) and self-reports by the worker or workplace administrator or manager. If a study presents both objective and subjective measurements, then we will prioritize objective measurements. We will include studies with measures from any data source, including registry data, in the same analyses and description.

Regarding years of data coverage in our systematic review, we will include studies that define exposure to long working hours in accordance with our standard definition (Table 1). Studies from any year will be included.

*3.2.1.3. Types of comparators*. The included comparator will be participants exposed to the theoretical minimum risk exposure level (Table 1). We will exclude all other comparators.

*3.2.1.4. Types of outcomes*. We will include studies that define alcohol consumption and alcohol use disorders in accordance with our standard definition of these two outcomes. We will include studies that have assessed absolute measures of alcohol consumption measured in grams of alcohol consumed per average week among drinkers (outcome 1) and/or the prevalence of, incidence of or mortality from any alcohol use disorders, as defined by the ICD-10 codes: F10, G72.1, Q86.0, ×45 (outcome 2) (Table 2). For alcohol consumption, we will include studies that measured the outcome using validated tools (e.g. AUDIT-C) (Bradley et al., 1998) or other self-reporting by means of questionnaire. For alcohol use disorders, we expect that most studies examining exposure to long working hours and its effect on these disorders have documented ICD-10 diagnostic codes. In the remaining cases, methods that approximate ICD-10 criteria will ascertain alcohol use disorders. We will include both objective and subjective measures of this outcome but will prioritize objective over subjective ones.

The following measurements of pneumoconiosis will be regarded as eligible:

i) Diagnosis by a physician.
ii) Hospital discharge record.
iii) Other relevant administrative records (e.g. records of sickness absence or disability).
iv) Medically certified cause of death.

All other measure will be excluded from this systematic review.

*3.2.1.5. Types of studies*. We will include studies that investigate the effect of long working hours on alcohol use and alcohol use disorders for any years. Eligible study designs will be randomized controlled trials (including parallel-group, cluster, cross-over and factorial trials), cohort studies (both prospective and retrospective), case-control studies, and other non-randomized intervention studies (including quasi-randomized controlled trials, controlled before-after studies and interrupted time series studies). We included a broader set of observational study designs than is commonly included, because a recent augmented Cochrane Review of complex interventions identified valuable additional studies using such a broader set of study designs (Arditi et al., 2016). As we have an interest in quantifying risk and not in qualitative assessment of hazard (Barroga and Kojima), we will exclude all other study designs (e.g. uncontrolled before-and-after, cross-sectional, qualitative, modelling, case and non-original studies).

Records published in any year and any language will be included. Again, the search will be conducted using English language terms, so that records published in any language that present essential information (i.e. title and abstract) in English will be included. If a record is written in a language other than those spoken by the authors of this review or those of other reviews in the series (Descatha et al., in press; Hulshof et al., under review; John et al., under review; Li et al., accepted; Mandrioli et al., in press; Rugulies et al., under review; Teixeira et al., under review; Tenkate et al., under review), then the record will be translated into English. Published and unpublished studies will be included. Studies conducted using unethical practices will be excluded (e.g., RCTs that deliberately exposed humans to a known risk factor to human health).

*3.2.1.6. Types of effect measures*. We will include measures of the relative effect of a relevant level of long working hours on the risk of having, developing or dying from stroke, compared with the theoretical minimum risk exposure level. Included relative effect measures are risk ratios and odds ratios for prevalence and mortality measures and hazard ratios for incidence measures (e.g. developed or died from stroke). Measures of absolute effects (e.g. mean differences in risks or odds) will be converted into relative effect measures, but if conversion is impossible, they will be excluded. To ensure comparability of effect estimates and facilitate meta-analysis, if a study presents an odds ratio, then we will convert it into a risk ratio, if possible, using the guidance provided in the Cochrane Collaboration's handbook for systematic reviews of interventions (Higgins and Green, 2011).

As shown in our logic model (Fig. 1), we a priori consider the following variables to be potential effect modifiers of the effect of long working hours on alcohol consumption and on alcohol use disorders: country, age, sex, industrial sector, occupation, and formality of employment. We consider age, sex, and socioeconomic position to be potential confounders. Potential mediators are work-related stress imposed by long-working hours and the individual worker's specific coping strategies.

If a study presents estimates for the effect from two or more alternative models that have been adjusted for different variables, then we will systematically prioritize the estimate from the model that we consider best adjusted, applying the lists of confounders and mediators identified in our logic model (Fig. 1). We will prioritize estimates from models adjusted for more potential confounders over those from models adjusted for fewer. For example, if a study presents estimates from a crude, unadjusted model (Model A), a model adjusted for one potential confounder (Model B) and a model adjusted for two potential confounders (Model C), then we will prioritize the estimate from Model C. We will prioritize estimates from models unadjusted for mediators over those from models that adjusted for mediators, because adjustment for mediators can introduce bias. For example, if Model A has been adjusted for two confounders, and Model B has been adjusted for the same two confounders and a potential mediator, then we will choose the estimate from Model A over that from Model B. We prioritize estimates from models that can adjust for time-varying confounders that are at the same time also mediators, such as marginal structural models (Pega et al., 2016) over estimates from models that can only adjust for time-varying confounders, such as fixed-effects models (Gunasekara et al., 2014), over estimates from models that cannot adjust for time-varying confounding. If a study presents effect estimates from two or more potentially eligible models, then we will explain specifically why we prioritized the selected model.

### 3.2.2. Information sources and search

*3.2.2.1. Electronic academic databases*. At a minimum, we (EB, ED, MCL COCL and ALCM) will search the seven following electronic academic databases:

1. International Clinical Trials Register Platform (to 30 June 2018).
2. Ovid MEDLINE with Daily Update (1946 to 30 June 2018).
3. PubMed (1946 to 30 June 2018).
4. EMBASE (1947 to 30 June 2018).
5. Web of Science (1945 to 30 June 2018).
6. CISDOC (1901 to 2012).
7. PsychInfo (1880 to 30 June 2018).

The Ovid Medline search strategy for Systematic Review 2 is presented in Appendix G. We will perform searches in electronic databases operated in the English language using a search strategy in the English language. We will adapt the search syntax to suit the other electronic academic and grey literature databases. When we are nearing completion of the review, we will search the PubMed database for the most recent publications (e.g., e-publications ahead of print) over the last six months. Any deviation from the proposed search strategy in the actual search strategy will be documented.

*3.2.2.2. Electronic grey literature databases*. At a minimum, we (EB, ED, MCL and ALCM) will search the two following electronic databases for grey literature:

1. OpenGrey (http://www.opengrey.eu/)
2. Grey Literature Report (http://greylit.org/)

*3.2.2.3. Internet search engines*. We (EB, ED, MCL, COCL and ALCM) will also search the Google (www.google.com/) and GoogleScholar (www.google.com/scholar/) Internet search engines and screen the first 100 hits for potentially relevant records.

*3.2.2.4. Organizational websites*. The websites of the seven following international organizations and national government departments will be searched by EB, ED, MCL, COCL and ALCM:

1. International Labour Organization (www.ilo.org/).
2. World Health Organization (www.who.int).
3. European Agency for Safety and Health at Work (https://osha.europa.eu/en).
4. Eurostat (www.ec.europa.eu/eurostat/web/main/home).
5. China National Knowledge Infrastructure (http://www.cnki.net/).
6. Finnish Institute of Occupational Health (https://www.ttl.fi/en/).
7. United States National Institute of Occupational Safety and Health (NIOSH) of the United States of America, using the NIOSH data and statistics gateway (https://www.cdc.gov/niosh/data/).

*3.2.2.5. Hand-searching and expert consultation*. We (EB, ED, MCL, COCL and ALCM) will hand-search for potentially eligible studies in:

- Reference list of previous systematic reviews
- Reference list of all included study records
- Study records published over the past 24 months in the three peer-reviewed academic journals with the largest number of included studies.
- Study records that have cited the included studies (identified in Web of Science citation database).
- Collections of the review authors.

Additional experts will be contacted with a list of included studies, with the request to identify potentially eligible additional studies.

### 3.2.3. Study selection

Study selection will be carried out with the Covidence or Rayyan Systematic Reviews Web App (Ouzzani et al., 2016). All study records identified in the search will be downloaded and duplicates will be identified and deleted. Afterwards, at least two review authors (out of: EB, ED, MCL, COCL and ALCM), working in pairs, will independently screen titles and abstracts (step 1) and then full texts (step 2) of potentially relevant records. A third review author (out of: LG, DVP, RR) will resolve any disagreements between the two review authors. If a study record identified in the literature search was authored by a review author assigned to study selection or if an assigned review author was involved the study, then the record will be re-assigned to another review author for study selection. The study selection will be documented in a flow chart in the systematic review, as per PRISMA guidelines (Liberati et al., 2009).

### 3.2.4. Data extraction and data items

A data extraction form will be developed and trialled until data extractors reach convergence and agreement. At a minimum, two review authors (out of: COCL, ALCM, DVP and RR) will extract data on study characteristics (including study authors, study year, study

country, participants, exposure and outcome), study design (including summary of study design, comparator, epidemiological models used and effect estimate measure), risk of bias (including selection bias, reporting bias, confounding, and reverse causation) and study context (e.g. data on. contemporaneous exposure to other occupational risk factors potentially relevant for deaths or other health loss from stroke.) A third review author (DVP or RR) will resolve conflicts in data extraction. Data will be entered into and managed with the Review Manager, Version 5.3 (RevMan 5.3) (2014) or DistillerSR (EvidencePartner, 2017) softwares, but the Health Assessment Workspace Collaborative (HAWC) (Shapiro, 2013) may also be used in parallel or to prepare data for entry into RevMan 5.3.

We will also extract data on potential conflict of interest in included studies. For each author and affiliated organization of each included study record, we will extract their financial disclosures and funding sources. We will use a modification of a previous method to identify and assess undisclosed financial interest of authors (Forsyth et al., 2014). Where no financial disclosure or conflict of interest statements are available, we will search the name of all authors in other study records gathered for this study and published in the prior 36 months and in other publicly available declarations of interests (Drazen et al., 2010a; Drazen et al., 2010b).

We will request missing data from the principal study author by email or phone, using the contact details provided in the principal study record. If we do not receive a positive response from the study author, we will send follow-up emails twice, at two and four weeks.

### 3.2.5. Risk of bias assessment

Standard risk of bias tools do not exist for systematic reviews for hazard identification in occupational and environmental health, nor for risk assessment. The five methods specifically developed for occupational and environmental health are for either or both hazard identification and risk assessment, and they differ substantially in the types of studies (randomized, observational and/or simulation studies) and data (e.g. human, animal and/or in vitro) they seek to assess (Rooney et al., 2016). However, all five methods, including the *Navigation Guide* (Lam et al., 2016c), assess risk of bias in human studies similarly (Rooney et al., 2016).

The *Navigation Guide* was specifically developed to translate the rigor and transparency of systematic review methods applied in the clinical sciences to the evidence stream and decision context of environmental health (Woodruff and Sutton, 2014), which includes workplace environment exposures and associated health outcomes. The guide is our overall organizing framework, and we will also apply its risk of bias assessment method in Systematic Review 2. The *Navigation Guide* risk of bias assessment method builds on the standard risk of bias assessment methods of the Cochrane Collaboration (Higgins et al., 2011) and the US Agency for Healthcare Research and Quality (Viswanathan et al., 2008). Some further refinements of the *Navigation Guide* method may be warranted (Goodman et al., 2017), but it has been successfully applied in several completed and ongoing systematic reviews (Johnson et al., 2016; Johnson et al., 2014; Koustas et al., 2014; Lam et al., 2016a; Lam et al., 2014; Lam et al., 2017; Lam et al., 2016b; Vesterinen et al., 2014). In our application of the *Navigation Guide* method, we will draw heavily on one of its latest versions, as presented in the protocol for an ongoing systematic review (Lam et al., 2016c). Should a more suitable method become available, we may switch to it.

We will assess risk of bias on the individual study level and on the body of evidence overall. The nine risk of bias domains included in the *Navigation Guide* method for human studies are: (i) source population representation; (ii) blinding; (iii) exposure assessment; (iv) outcome assessment; (v) confounding; (vi) incomplete outcome data; (vii) selective outcome reporting; (viii) conflict of interest; and (ix) other sources of bias. While two of the earlier case studies of the *Navigation Guide* did not utilize outcome assessment as a risk of bias domain for studies of human data (Johnson et al., 2014; Koustas et al., 2014; Lam et al., 2014; Vesterinen et al., 2014), all of the subsequent reviews have included this domain (Johnson et al., 2016; Lam et al., 2016a; Lam et al., 2017; Lam et al., 2016b; Lam et al., 2016c). Risk of bias or confounding ratings will be: “low”; “probably low”; “probably high”; “high” or “not applicable” (Lam et al., 2016c). To judge the risk of bias in each domain, we will apply a priori instructions (Appendix H), which we have adopted or adapted from an ongoing *Navigation Guide* systematic review (Lam et al., 2016c). For example, a study will be assessed as carrying “low” risk of bias from source population representation, if we judge the source population to be described in sufficient detail (including eligibility criteria, recruitment, enrollment, participation and loss to follow up) and the distribution and characteristics of the study sample to indicate minimal or no risk of selection effects. The risk of bias at study level will be determined by the worst rating in any bias domain for any outcome. For example, if a study is rated as “probably high” risk of bias in one domain for one outcome and “low” risk of bias in all other domains for the outcome and in all domains for all other outcomes, the study will be rated as having a “probably high” risk of bias overall.

All risk of bias assessors (COCL, ALCM, DVP and RR) will jointly trial the application of the risk of bias criteria until they have synchronized their understanding and application of these criteria. At least two study authors (out of: COCL, ALCM, DVP and RR) will independently judge the risk of bias for each study by outcome. Where individual assessments differ, a third author (out of: COCL, ALCM, DVP or RR) will resolve the conflict. In the systematic review, for each included study, we will report our study-level risk of bias assessment by domain in a standard ‘Risk of bias’ table (Higgins et al., 2011). For the entire body of evidence, we will present the study-level risk of bias assessments in a ‘Risk of bias summary’ figure (Higgins et al., 2011).

### 3.2.6. Synthesis of results

We will conduct meta-analyses separately for estimates of the effect on incidence and mortality. Studies of different designs will not be combined quantitatively. If we find two or more studies with an eligible effect estimate, two or more review authors (out of: COCL, ALCM, DVP and RR) will independently investigate the clinical heterogeneity of the studies in terms of participants (including country, sex, age and industrial sector or occupation), level of risk factor exposure, comparator and outcomes. If we find that effect estimates differ considerably by country, sex and/or age, or a combination of these, then we will synthesise evidence for the relevant populations defined by country, sex and/or age, or combination thereof. Differences by country could include or be expanded to include differences by country group (e.g. WHO region or World Bank income group). If we find that effect estimates are clinically homogenous across countries, sexes and age groups, then we will combine studies from all of these populations into one pooled effect estimate that could be applied across all combinations of countries, sexes and age groups in the WHO/ILO joint methodology.

If we judge two or more studies for the relevant combination of country, sex and age group, or combination thereof, to be sufficiently clinically homogenous to potentially be combined quantitatively using quantitative meta-analysis, then we will test the statistical heterogeneity of the studies using the $I^2$ statistic (Figueroa, 2014). If two or more clinically homogenous studies are found to be sufficiently homogenous statistically to be combined in a meta-analysis, we will pool the risk ratios of the studies in a quantitative meta-analysis, using the inverse variance method with a random effects model to account for cross-study heterogeneity (Figueroa, 2014). The meta-analysis will be conducted in RevMan 5.3, but the data for entry into these programmes may be prepared using another recognized statistical analysis programme, such as Stata. We will neither quantitatively combine data from studies with different designs (e.g. combining cohort studies with case-controls studies), nor unadjusted and adjusted models. We will only combine studies that we judge to have a minimum acceptable level of adjustment for confounders. If quantitative synthesis is not feasible,

then we will synthesise the study findings narratively and identify the estimates that we judged to be the highest quality evidence available.

#### 3.2.7. Additional analyses

If we source micro-data on exposure, outcome and potential confounding variables, we may conduct meta-regressions to adjust optimally for potential confounders.

If there is evidence for differences in effect estimates by country, sex, age, industrial sector and/or occupation, or by a combination of these variables, then we will conduct subgroup analyses by the relevant variable or combination of variables, as feasible. Where both studies on workers in the informal economy and in the formal economy are included, then we will conduct sub-group analyses by formality of economy. Findings of these subgroup analyses, if any, will be used as parameters for estimating burden of disease specifically for relevant populations defined by these variables. We will also conduct subgroup analyses by study design (e.g. randomized controlled trials versus cohort studies versus case-control studies).

We will perform a sensitivity analyses that will include only studies judged to be of "low" or "probably low" risk of bias from conflict of interest; judged to be of "low" or "probably low" risk of bias; and with documented or approximated ICD-10 diagnostic codes. We may also conduct a sensitivity analysis using an alternative meta-analytic model, namely the inverse variance heterogeneity (IVhet) model.

#### 3.2.8. Quality of evidence assessment

We will assess quality of evidence using a modified version of the *Navigation Guide* quality of evidence assessment tool (Lam et al., 2016c). The tool is based on the GRADE approach (Schünemann et al., 2011) adapted specifically to systematic reviews in occupational and environmental health (Morgan et al., 2016). Should a more suitable method become available, we may switch to it.

We (COCL, ALCM, DVP and RR) will assess quality of evidence for the entire body of evidence by outcome, with any disagreements resolved by a third review author (AD, GS or SI). We will adopt or adapt the latest *Navigation Guide* instructions (Appendix D) for grading the quality of evidence (Lam et al., 2016c). We will downgrade the quality of evidence for the following five GRADE reasons: (i) risk of bias; (ii) inconsistency; (iii) indirectness; (iv) imprecision; and (v) publication bias. If our systematic review includes ten or more studies, we will generate a funnel plot to judge concerns on publication bias. If it includes nine or fewer studies, we will judge the risk of publication bias qualitatively. To assess risk of bias from selective reporting, protocols of included studies, if any, will be screened to identify instances of selective reporting.

We will grade the evidence, using the three *Navigation Guide* standard quality of evidence ratings: "high", "moderate" and "low" (Lam et al., 2016c). Within each of the relevant domains, we will rate the concern for the quality of evidence, using the ratings "none", "serious" and "very serious". As per *Navigation Guide*, we will start at "high" for randomized studies and "moderate" for observational studies. Quality will be downgrade for no concern by nil grades (0), for a serious concern by one grade (−1) and for a very serious concern by two grades (−2). We will up-grade the quality of evidence for the following other reasons: large effect, dose-response and plausible residual confounding and bias. For example, if we have a serious concern for risk of bias in a body of evidence consisting of observational studies (−1), but no other concerns, and there are no reasons for upgrading, then we will downgrade its quality of evidence by one grade from "moderate" to "low".

#### 3.2.9. Strength of evidence assessment

We (COCL, ALCM, DVP and RR) will apply the standard *Navigation Guide* methodology (Lam et al., 2016c) to rate the strength of the evidence. The rating will be based on a combination of the following four criteria: (i) quality of the body of evidence; (ii) direction of the effect; (iii) confidence in the effect; and (iv) other compelling attributes of the data that may influence our certainty. The ratings for strength of evidence for the effect of long working hours on stroke will be "sufficient evidence of toxicity/harmfulness", "limited of toxicity/harmfulness", "inadequate of toxicity/harmfulness" and "evidence of lack of toxicity/harmfulness" (Appendix I).

## Financial support

IDI, COCL, NL, ALCM, FP, RR and YU and AMPU are salaried staff members of their respective organizations. This journal article was prepared with financial support from the World Health Organization cooperative agreement with the Centres for Disease Control and Prevention National Institute for Occupational Safety and Health of the United States of America on implementing Resolution WHA 60.26 "Workers' Health: Global Plan of Action" (Grant 1 E11 OH0010676-02).

## Sponsors

The sponsors of this systematic review are the World Health Organization and the International Labour Organization.

## Author contributions

IDI, NL, FP and AMPU had the idea for the systematic review. IDI, NL, FP and YU gathered the review team. FP led and all authors contributed to the development of the standard methodology for all systematic reviews in the series. FP led and all authors contributed to the development and writing of the standard template for all protocols in the series. LG and DP are the lead reviewers of this systematic review. LG and DVP wrote the first draft of this protocol, using the protocol template prepared by FP, and EB, ED, LG, MCL, COCL, ALCM, DVP, FP, RR, YU and AMPU made substantial contributions to revisions of the manuscript. The search strategy was developed and piloted by DVP in collaboration with a research librarian. LG and FP are experts in epidemiology, EB, ED, LG and MCL are experts in alcohol research, and COCL, ALCM, DVP, FP and RR are experts in systematic review methodology. FP coordinated all inputs from World Health Organization, International Labour Organization and external experts and ensured consistency across the systematic reviews of the series. LG and DVP are the guarantors of the systematic reviews.

## Acknowledgments

We thank Alexis Descatha, Diana Gagliardi, Jian Li, Reiner Rugulies and Grace Sembajwe for their feedback on an earlier version of this protocol. We thank Frida Fischer, Anders Knutsson and Mikael Sallinen for their feedback on the search strategy. We are grateful to Lisa Bero, Rebecca Morgan, Susan Norris, Holger J. Schünemann, Gretchen Stevens, Patrice Sutton, and Tracey Woodruff for their feedback on the methods for this protocol. We thank Paul Whaley and Tim Driscoll for their editorial guidance. The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

## Conflict of interest

None declared.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envint.2018.07.025.

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