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Research into Women's Health and Occupation (Non-Malignant Diseases) – an Umbrella Review

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1 Introduction

1.1 Background

The Industrial Injuries Disablement Benefit (IIDB) scheme provides a non-contributory benefit for disablement due to occupational accidents or prescribed diseases arising during work, where prescribed diseases are those for which there is a recognised link between the disease and occupation. Such diseases are either almost uniquely occupational or rely on the balance of probabilities based on epidemiological evidence to determine attribution to work. Most diseases are prescribed on the basis of studies of male workers and only a small proportion of new claims for IIDB are made by women (personal communication, IIAC committee).

Employment trends show that an increasing proportion of women are now in paid employment in the UK (Figure 1), with 15.7 million women aged 16 and over in employment in October to December 2022 (of whom 9.7 million were working full time, while 5.9 million were working part time)[1] and this trend is forecasted to continue to increase.

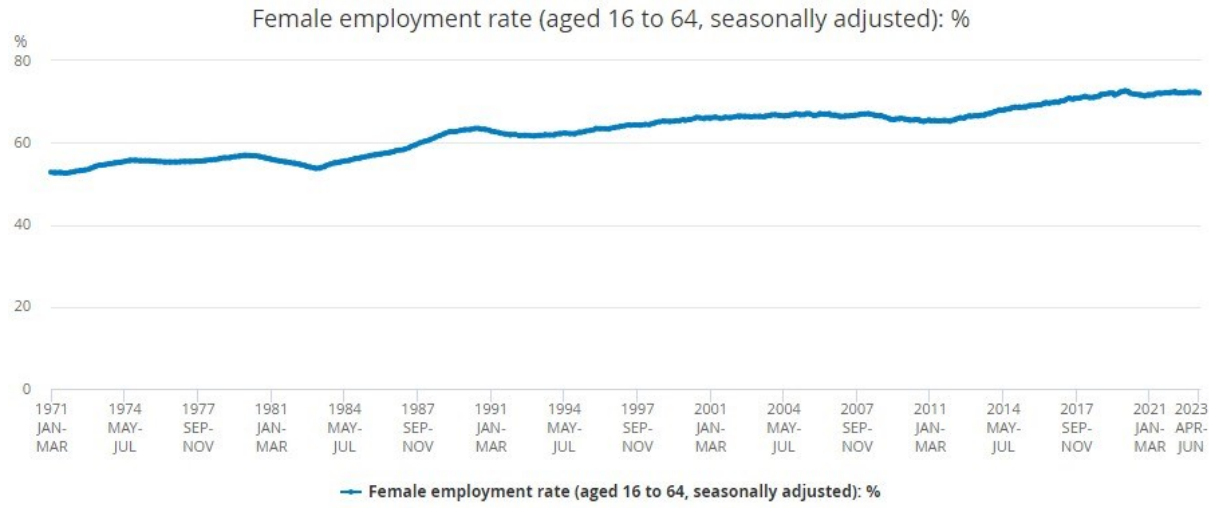

Figure 1: Proportion of females in active employment - extracted from https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/lf25/lms in September 2023

The Industrial Injuries Advisory Council (IIAC) commissioned the IOM to evaluate the specific issue of women's health due to workplace exposures, and to carry out an umbrella review to inform the potential for a more detailed evaluation of specific health outcomes and occupations relevant to women's health.

1.2 Aims and objectives

This research comprised an umbrella review of the epidemiology literature on work and non-malignant diseases relevant to women in workforce, in order to complete the following objectives:

i. To search for reviews published in the peer-reviewed literature and (where absent for a topic) large-scale cohort or case-control studies to identify the industries and/or occupations and/or exposures associated with non-malignant occupational diseases that occur
    a. only in women, or
    b. where women are at greater risk than men where both are similarly exposed.

[1] https://researchbriefings.files.parliament.uk/documents/SN06838/SN06838.pdf

ii. To give an approximate estimate, where feasible, of the range of the magnitude of the risks and the numbers/proportions of working women likely to be affected.
iii. To assess the size of the literature base for outcomes/exposures for more detailed evaluation of specific health outcomes and occupational circumstances.
iv. To produce a final report and brief interim reports as appropriate.

1.3 Scope of the study

The scope of the study was non-malignant disease relevant to women's health. Health endpoints of interest comprised those which occur solely in women (e.g. certain reproductive outcomes) and those which occur in occupational circumstances in which more women than men are employed (e.g. healthcare, education*).* The scope includes ill health caused by a woman's employment but excludes the impact of non-work-related health issues on ability to work (e.g. menopausal issues). While the study identifies the size of the literature base for the identified health endpoints and occupations, data extraction was carried out with a focus on review articles (and hence it is an umbrella review).

1.4 Format of this report

Within this report, we provide details of the methods used to identify relevant reviews and provide a brief summary of each included review following assessment of the title and abstract by two independent reviewers. The summary typically includes the topic of the review, the number of papers included and a brief outline of the study findings, extracted directly from the text of the paper. As the principal aim of this study is to provide information to help inform the selection of topics for more in-depth review, it is outside the scope to provide detailed data extraction or full analysis of each identified publication. Within the report the words 'sex' and 'gender' and the words 'women' and 'female' are used interchangeably, reflecting the terminology used within each of the included reviews.

2 Methods

2.1 Development of the search strategy

The first task of this research was to develop a search strategy. This was initiated by looking at information on employment patterns in women and by looking at three general reviews of gender and occupational health highlighted prior to commencement of the study[2,3,4]. We identified 14 occupations/occupational groups with over 100,000 women workers in the UK. These comprised: healthcare, admin/office roles, childcare, cleaning, animal care, hair and beauty, teaching, retail, pharmacy, social services/work, welfare, hospitality, science and fitness. We selected key occupations from this list that covered a range of working conditions to carry out a preliminary search on Google Scholar to identify the most relevant occupations and health endpoints to guide the development of the literature search strategy. These were healthcare, teaching, hair and beauty, admin/office roles and hospitality, and were selected to cover different types of exposures (e.g. standing for long periods of time, stress, exposures to chemicals). For the rest of the occupations/occupational groups, a more high-level search was carried out. Table 1 summarises these preliminary findings.

Trends emerging from the preliminary findings include that:

- Anxiety and depression were the most commonly identified/reported health endpoints related to occupation/occupational groups.
- Reproductive outcomes seem to be most commonly associated with occupations that use chemicals such as those used in cleaning and hair and beauty.

In addition to the findings of the preliminary assessment, following discussion with the IIAC committee, whole body vibration was included as an additional exposure. While some specific health outcomes (e.g. respiratory health or cardiovascular health) were not identified in these preliminary findings, reviews relevant to these topics are likely to have been identified in the searches focused on specific occupational groups which did not specify any particular health outcome (e.g. searches on 'healthcare workers and health').

2.2 Trial literature searches

Based on these findings, we carried out a series of searches within the Web of Science database of peer-reviewed literature, which identified the total number of papers published within the last 20 years, the number of reviews published within the last 20 years and the number of reviews published within the last 10 years. Searches were carried out for each of the health outcomes and each of the occupations/occupational groups identified. Tables 2 and 3 summarise the outcome of the trial searches. The tables show the different search strings investigated for each health outcome (Table 2) and occupational group (Table 3), the total number of papers (last 20 years) and total number of reviews (last 20 years and last 10 years). The proposed search strings for use in the study are highlighted in **BOLD** in the tables.

[2] Sex and Gender Differences in Occupational Hazard Exposures: a Scoping Review of the Recent Literature- https://link.springer.com/article/10.1007/s40572-021-00330-8
[3] Differences between men and women in their risk of work injury and disability: A systematic review- https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.23364
[4] Development and evaluation of the gender-specific CONSTANCES job exposure matrix for physical risk factors in France- https://doi.org/10.5271/sjweh.4118

Table 1: Summary of findings of preliminary assessment of the literature.

xx = appears in three or more review papers within the literature ; x = appears in only one or two review papers within the literature.

Occupation	Number of women employed in UK	Health Endpoints				
		Musculoskeletal issues	Reproductive problems	Anxiety and Depression	Burnout	Obesity
Admin/office roles	3,723,336	xx		x		
Healthcare	1,964,497	xx		xx	x	
Teaching	1,429,529	x			x	x
Retail	711,248	x		xx	x	
Hospitality	696,149			xx	x	
Cleaning	627,788	xx	xx	xx		
Childcare	523,976					
Hair and Beauty	253,054	xx	xx			
Pharmacy	141,099					
Welfare	131,146			xx	x	
Fitness	114,824					
Social services/work	113,861			xx		
Science	105,665		x			
Animal care	104,687			xx	xx	

Table 2: Outputs from trial searches of health outcomes (proposed search strings highlighted in **bold**)

NOTE: All searches included the string: ***(female or gender or women) and (job or occupation or work)***

Search string	Number of results	Number of reviews in last 20 years	Number (%) of reviews in last 10 years
Anxiety, depression and burnout			
(anxiety or depression or stress or burnout)	88,400	4,809	4,006 (83%)
(anxiety or depression or stress or burnout) not COVID	88,113	4,608	3,805 (83%)
(anxiety or depression or stress or "mental health" or burnout)	105,273	**5,777**	4,822 (83%)
(anxiety or depression or stress or "mental health" or burnout) not COVID	98,995	5,533	4,578 (83%)
Musculoskeletal disorders			
(musculoskeletal)	9,578	589	471 (80%)
(musculoskeletal or musculoskeletal health or musculoskeletal disorder or musculoskeletal complaint)	9,578	**589**	471 (80%)
Health effects from whole body vibration			
(whole body vibration)	241	**36**	26 (72%)

Search string	Number of results	Number of reviews in last 20 years	Number (%) of reviews in last 10 years
Reproductive issues			
(reproductive or low birth weight or congenital abnormalities or spontaneous abortion or miscarriage)	53, 848	**4,735**	3,741 (79%)
(low birth weight or congenital abnormalities or spontaneous abortion or miscarriage)	7,883	773	589 (76%)
(low birth weight or congenital abnormalities or spontaneous abortion or miscarriage or endometriosis or polycystic ovarian syndrome)	11,327	1,312	1,062 (81%)
Obesity-related health effects			
(obesity or overweight)	28,834	**1,698**	1,434 (84%)
(overweight)	26,443	1,603	1,350 (84%)

Table 3: Outputs from trial searches of occupations/occupational groups (proposed search strings highlighted in **bold**)

NOTE: All searches included the string: ***(female or gender or women) and (job or occupation or work)***

Search string	Number of results	Number of reviews in last 20 years	Number of reviews in last 10 years
Teaching			
(teaching or teacher) and (health)	8,798	357	307 (86%)
(teaching or teacher or education) and (health)	81,010	3,644	3,159 (87%)
(teaching or teacher or teaching assistant or education) and (health)	81,030	3,646	3,161 (87%)
(teaching or teacher* or teaching assistant*) and (health)	9,505	**373**	320 (86%)
Administrative/Office roles			
(admin or administration or office) and (health)	32,828	1,543	1,284 (83%)
(admin or administration or office or secretary or assistant or receptionist or human resources or library clerk or librarian office manager or financial administration or book keeper or pay roll manager or typist) and (health)	43,969	**2,034**	1,677 (82%)
Healthcare			
(healthcare worker or healthcare assistant) and (health)	4,306	231	219 (95%)
(healthcare) and (health)	27, 462	1,788	1,607 (90%)
(healthcare workers or healthcare assistant or doctor or nurse) and (health)	21, 938	1,133	943 (83%)
(healthcare workers or healthcare assistant or doctor or nurse or midwife) and (health)	23,559	1,240	1,036 (84%)

Search string	Number of results	Number of reviews in last 20 years	Number of reviews in last 10 years
(healthcare workers or healthcare assistant or doctor or nurse or midwife or dental nurse or speech and language therapist or occupational therapist or healthcare practice manager or care worker or home carer) and (health)	28, 907	**1,520**	1,255 (83%)
Retail			
(retail or sales assistant or store assistant or store manager or cashier) and (health)	440	15	12 (80%)
(retail or sales assistant or store assistant or store manager or cashier or sales associate or customer service) and (health)	899	**29**	24 (83%)
Hospitality			
(hospitality or waitress or hotel or restaurant worker or events manager) and (health)	968	51	36 (71%)
(hospitality or waitress or waiter or bar staff or bartender or barista or hotel receptionist or hotel manager or concierge or restaurant worker or events manager or events coordinator or chef) and (health)	747	44	31 (70%)
(hospitality or waitress or waiter or bar staff or bartender or barista or hotel receptionist or hotel manager or concierge or restaurant worker or events manager or events coordinator or chef or baker or catering or wedding planner) and (health)	2,873	**147**	114 (78%)

Search string	Number of results	Number of reviews in last 20 years	Number of reviews in last 10 years
Cleaning			
(cleaning or cleaner or cleaning person) and (health)	1,660	56	42 (75%)
(cleaning or cleaner or cleaning person or housekeeper) and (health)	1,702	**58**	44 (76%)
Childcare			
(childcare or childminder or playworker or nursery worker or nursery nurse or nursery staff) and (health)	1,113	46	42 (91%)
(childcare or childminder or playworker or nursery worker or nursery nurse or nursery staff or nursery assistant) and (health)	1,117	**46**	44 (96%)
Hair and Beauty			
(hairdresser or nail technician or eyelash technician or beautician or beauty therapist or spa therapist or barber) and (health)	482	34	28 (82%)
(hairdresser or nail technician or eyelash technician or beautician or beauty therapist or spa therapist or barber or salon manager or beauty manager) and (health)	486	**34**	28 (82%)
Pharmacy			
(pharmacy or pharmacist or pharmaceutical technician or pharmacy assistant or dispensing technician) and (health)	10,053	**705**	624 (89%)
Welfare			
(welfare professional) and (health)	885	**34**	31 (91%)

Search string	Number of results	Number of reviews in last 20 years	Number of reviews in last 10 years
Fitness			
(fitness instructor or gym instructor or gym teacher or personal trainer) and (health)	105	**1**	1 (100%)
Social services			
(social service or social service work or social worker or social service manager) and (health)	26,970	**1,419**	1,210 (85%)
Science			
(scientist or social scientist or humanities scientist or biological scientist or biochemist or laboratory technician) and (health)	4,495	**356**	298 (84%)
Animal care			
(veterinarian or veterinary nurse or animal care service) and (health)	821	**32**	29 (91%)

2.3 Trial literature searches

The volume of papers identified across the specified occupations and health outcomes was very large and it was therefore agreed that we would focus on reviews. Given that the difference in the number of reviews from the past 20 years or past 10 years was relatively small, we included reviews from the past 20 years (from 2004 onwards).

Where we trialled several search strings, we decided to use the most comprehensive (i.e. the one with the most 'hits') except where we thought this would cause a substantial number of irrelevant publications to be included (e.g. inclusion of 'education' in the search string for teaching increases the number of publications by a factor of 10, most of which referred to education in the context of unrelated areas of research).

While the COVID-19 pandemic will have contributed to workplace stress and anxiety, studies specifically of COVID-related mental health issues were agreed to be out of scope, however we did not specifically exclude studies which mention COVID at this stage.

Using the proposed trial search strings resulted in a total of 12,835 reviews identified on the basis of health outcomes and 6,788 reviews identified on the basis of occupation/occupational group, not accounting for duplicates.

3 Results

3.1 Results of the literature screening

When the final agreed search strings were run to identify reviews relevant to the study, an additional 30 reviews were found compared to the trial searches, resulting in a total of 19,653 reviews (including duplicates) identified for screening using title and abstract. Duplicates were identified for 5,179 reviews, resulting in 14,474 reviews to be screened. Screening was carried out using Covidence literature review software. The software ordered the reviews by perceived relevance using AI, and as the screening progressed, it became clear that there were few to no relevant reviews among those which occurred further down the list. The final 4,000 reviews were therefore automatically excluded from the study. Assessment of the remaining 10,474 reviews was carried out independently by two reviewers, with discrepancies in classification jointly reviewed and an agreed classification determined. The outcome of the screening is shown in Figure 2.

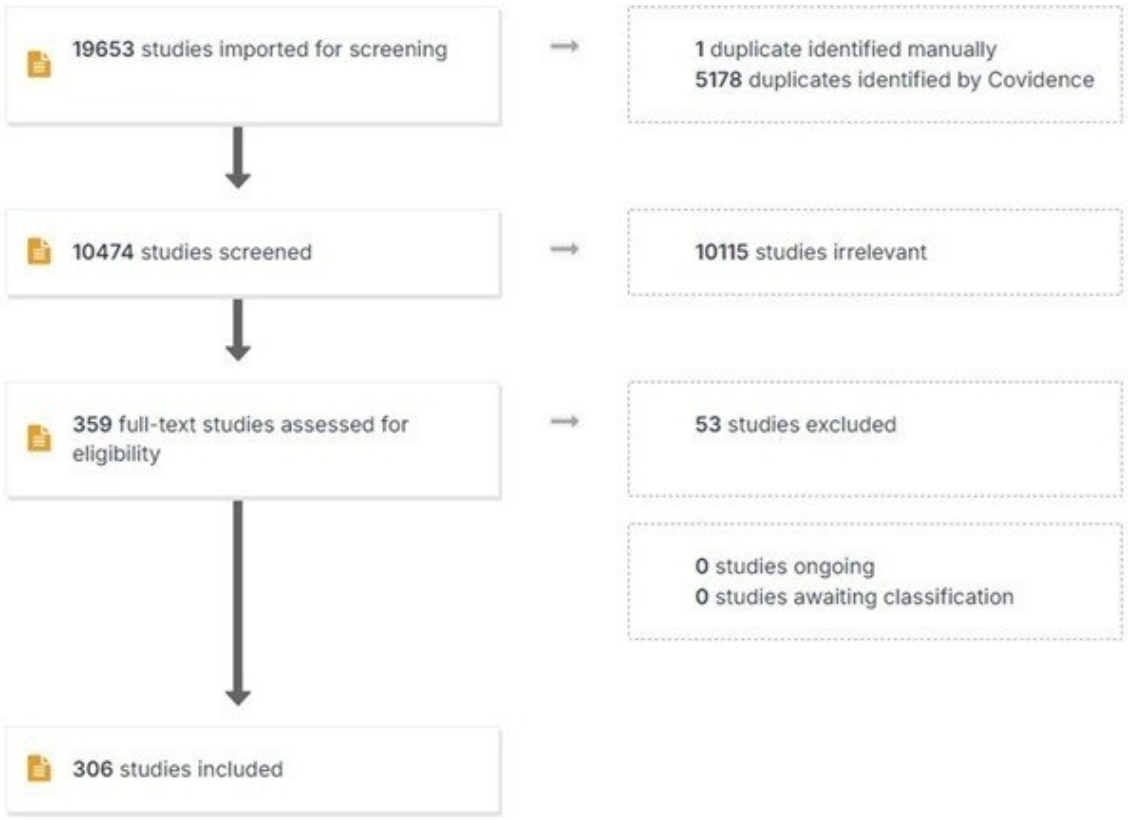

Figure 2: Outcome of screening of relevant reviews (excluding final 4,000 as noted above)

The distribution of the included studies by occupation and health outcomes is shown in Table 4.

Table 4: Distribution of 306 included reviews by occupation and health outcome.

	Grouped Health Outcome					
Occupational Group	Mental Health	Musculoskeletal	Other/General	Reproductive	Violence/Assault	Grand Total
Animal care	4					4
Carers		2				2
Childcare			1			1
Cleaners			2			2
Fitness	7		2			9
Hairdressing		2		3		5
Healthcare	64	12	25	8	14	123
Hospitality	3		1		1	5
Office Worker		3	4			7
Other	15	2	17	3	2	39
Scientists	1		1			2
Shiftwork	1		4	8		13
Social Workers	2					2
Teachers	12	2	2		1	17
Various	17	8	22	20	8	75
Grand Total	126	31	81	42	26	306

Included reviews were each assessed for relevance to the study aims, with key findings extracted for those identified as relevant. During this stage of the work, discussions took place with the IIAC committee to clarify the scope of the study and relevance of some reviews where this was unclear. The following decisions were made and subsequently implemented:

- Reviews for some specific occupations which do not fall under the remit of IIAC were excluded – these comprised military occupations and sex workers
- Reviews where the health outcome was specified only as 'burnout' were excluded as this was determined by the IIAC committee to be too non-specific as an outcome
- Reviews on reproductive health were included only where these looked at the health impact on the parent, not on the child. This could include mental health problems in parents caused by adverse birth outcomes such as miscarriage
- Reviews on injuries were excluded
- Reviews which were clearly not relevant to the UK were excluded, although reviews from other countries were included where it was considered that circumstances were broadly consistent with the UK experience
- Reviews which did not explicitly address women's health at work were excluded
- Reviews not in the English language were excluded

Full texts could not be sourced for 73 of the 306 reviews identified. It was possible to determine from the abstracts of 65 of these reviews that they were not relevant to the study under one of the reasons listed above and so there remained only 8 reviews of potential relevance which could not be sourced.
Details of the 306 included reviews are provided in the accompanying spreadsheet, with findings from the more detailed assessment summarised below by occupation. Where there were a large number of identified reviews (typically >5 reviews), the focus was on the most recently published unless they covered different aspects of women's work and health, in which case they were all included.

3.2 Key findings by occupation

3.2.1 Animal Care Workers

Four reviews were identified for animal care workers, all of which were related to mental health problems. One review focused on burnout and so was excluded. The remaining three reviews were of the mental health problems of veterinarians. A scoping review by Pohl et al, 2022 was included in the review by Stetina and Krouzecky, 2022 and so

has not been assessed separately. Stetina and Krouzecky reported that of eight studies on veterinary practice six suggested that female sex may have an adverse impact on the mental health of veterinarians with female veterinarians significantly more stressed by their work than the general population, but also than their male colleagues (higher values of psychological distress, such as depression or anxiety, a higher level of negative attitudes toward social support). Platt et al, 2012 reported that a study of suicidal behaviour in 849 New Zealand veterinary surgeons showed that female veterinarians and veterinarians working in small animal practice were more likely to report suicidal ideation and that psychological distress was significantly higher in female than male veterinarians. The study also reported that depression was more frequently reported by females than males and current depression was reported more frequently by younger females than older females.

One further review (Fink-Miller and Nestler, 2018) reviewed suicide occurrence in physicians and veterinarians (included in the section on healthcare workers below). They reported that data collected from the Office for National Statistics in England and Wales indicated a PMR of 361 for male veterinarians, and 414 for female veterinarians when compared to the general population, similar to the pattern observed in physicians.

3.2.2 Care Workers

Two reviews were identified for care workers, both of which were related to musculoskeletal disorders (MSDs). Both reviews were excluded, one was on unpaid carers (Abdullahi et al, 2023) and the other was both non-UK based and focused on healthcare workers more generally (Mehrdad et al, 2016).

3.2.3 Childcare workers

Only one review was identified for childcare workers, which was related to the immune status for a range of diseases (e.g. rubella, pertussis, measles) among persons caring for children in day care and so was excluded as outside the scope of this study as it did not directly assess a health outcome among workers (Kofahl et al, 2020).

3.2.4 Cleaners

Two reviews were identified for cleaners, one of which was excluded as it focussed on domestic workers in the Middle East and South East Asia and their adverse working conditions. The other review (Folletti et al, 2017) considered prevalence of asthma among cleaners. The review noted that the majority of those carrying out occupational (and domestic) cleaning were women, and that often occupational cleaning takes place in healthcare settings (e.g. within operating theatres). Exposure to the range of chemicals in cleaning products was associated with the occurrence of asthma but although the authors noted that women tended to have a higher risk for asthma than men, this was not examined specifically for individuals exposed to cleaning products.

3.2.5 Fitness Workers/Athletes

Seven reviews assessed adverse mental health among fitness workers/athletes, of which 5 were excluded (3 due to a focus on burnout, one on eating disorders and one which was a scoping study). Neither of the two included reviews on mental health problems were systematic reviews. Pascoe et al, 2022 carried out a narrative review of psychosocial stressors influencing mental health among women athletes and concluded that compared with men athletes, women athletes are at greater risk of a range of psychological stressors that contribute to health concerns and mental health disorders, which can impact their career satisfaction and longevity. Stressors included psychological and physical harassment and abuse, sexual harassment and abuse and neglect. Frank et al, 2013 noted that there are too few studies, and notably few studies with clinically valid criteria for assessment of mental health problems, on elite athletes available to draw representative conclusions. In addition, Frank et al did not consider gender differences in their analysis.

Two additional reviews on fitness workers/athletes were identified, one studying urinary incontinence in athletes (Pires et al, 2020) and one on injuries in youth football players which was excluded as it was outside the scope of this umbrella review. Pires et al carried out a systematic review of nine studies. A meta-analysis showed a 25.9% prevalence for urinary incontinence, and 20.7% prevalence for stress urinary incontinence, in female athletes in different sports. The most prevalent high impact sport (as defined by the authors of the review) was volleyball, with the value of 75.6%. They concluded that the prevalence of urinary incontinence can be high in female athletes, with high-impact sports potentially increasing the risk for stress urinary incontinence and called for further research regarding the potential risk factors related to the onset of urinary incontinence.

3.2.6 Hairdressers

Two reviews studied MSDs in hairdressers, one of which was excluded as it was a cross-sectional study rather than a review. Kozak et al, 2019 carried out a scoping review of work-related MSDs in hairdressing. Nineteen studies, all but one of which predominantly included females, provided data on MSD prevalence, with the highest 12-month prevalence reported for the lower back (range 13-76%), neck (range 9-58%), shoulder (range 28-60%) and hand/wrist (range 11-53%). In comparison to other occupational groups, hairdressers reported more frequent MSDs in all body regions or exhibited a greater risk of leaving the profession for health reasons. Table 3 of the paper reports an OR of 3.1 ($p<0.05$) for work-related upper limb disorder in female hairdressers compared to male hairdressers but it is unclear how this value was calculated.

Three reviews studied reproductive health among hairdressers. Babic et al, 2022 concluded from six studies with various designs and a range of reproductive outcomes (e.g. preterm delivery), that none showed a significantly increased risk in hairdressers. One study showed that, compared to the general population, hairdressers setting permanent waves for more than four times per week had a significantly prolonged time to pregnancy (fecundability ratio 0.86; 95%CI: 0.76–0.97), similar to those bleaching hair for up to four times per week (0.88; 95% CI: 0.78–0.99), dyeing with oxidative formulations for more than two times per week (0.83; 95% CI: 0.73–0.94), and those dyeing with direct- acting dyes (0.86; 95% CI: 0.76–0.96). Henrotin et al, 2015 reviewed 19 studies from which combined risk ratios (RRc) were calculated. The adjustment for potential confounders varied across the 19 studies with most adjusting for age and smoking habit, but few adjusting for variables associated with socio-economic status (e.g. education level, income). RRc were significantly increased for: time to pregnancy (RRc 1.11; 95% CI: 1.03−1.19); premature birth (RRc 1.05; 95% CI: 0.99−1.11); and embryonic and fetal losses, (RRc 1.19; 95% CI: 1.03−1.38). They concluded that the study confirms a weak increase in risk of some reproductive disorders in female hairdressers/cosmetologists which could be due to physical risks, mental demands, and/or exposure to chemical products. Peters et al, 2010 considered 2 reviews and 26 original studies on fertility disorders and pregnancy complications in hairdressers including a range of reproductive outcomes. Findings of the included studies were inconsistent (e.g. of 7 studies of malformation, two found statistically significant increased risks and five did not). The authors concluded that no clear statements on an association between the exposure as a hairdresser and the effect on reproduction were possible.

3.2.7 Healthcare workers

Around 40% of all the papers identified were for healthcare workers, and thus the current section is subdivided by health outcome.

Mental health

Most reviews on the health of healthcare workers were on adverse mental health outcomes. A total of 66 papers were identified. For two of these reviews full texts could not be sourced, and 50 reviews were excluded (30 focused on burnout; 7 were non-UK relevant; 1 not in English, 1 narrative review; 5 on generic wellbeing; 1 case study; 2 on COVID; 1 on moral distress, 1 on compassion fatigue, and 1 not a review).

Suicide

Groves et al, 2023 investigated the factors associated with suicide among nurses and midwives in a systematic review of 100 studies. Several studies confirmed that nursing professionals, especially females, were at increased risk of suicide, particularly by self-poisoning. Factors contributing to risk include psychiatric disorders, alcohol and substance misuse, physical health problems, and occupational and interpersonal difficulties. The authors concluded there was substantial evidence that nursing professionals had an increased risk of suicide relative to the general population and some other occupational groups, with the weight of evidence indicating risk was particularly elevated in female nurses.

Two further reviews (Hernandez et al, 2023; Harvey et al, 2021) looked at the prevalence of and factors associated with suicide in physicians. Both concluded that there was some evidence of higher risk among female than male physicians. In both reviews, this conclusion was primarily based on the findings of two earlier reviews, Duarte et al, 2020 and Duthiel et al 2019, both of which are also included in the current umbrella review. There was substantial overlap in the papers considered by these two reviews and so the results presented here are not independent. Duarte et al included 32 articles in a systematic review, of which 9 articles and data sets were included in a meta-analysis. Meta-analysis results showed a significantly higher suicide SMR in female physicians compared with women in general (1.46; 95% CI: 1.02-1.91) and a significantly lower suicide SMR in male physicians compared with men in general (0.67; 95% CI: 0.55-0.79). Male and female physician SMRs significantly decreased after 1980 vs before 1980. No evidence of publication bias was found. Duthiel et al, 2019 conducted a systematic review and meta-analysis on suicide risk among healthcare workers. The

overall SMR for suicide in physicians, based on 47 studies, was 1.44 (95% CI: 1.16-1.72) although the authors noted that there was an important degree of heterogeneity (I^2 = 93.9%). Females were at higher risk (SMR = 1.9; 95% CI: 1.49-2.58).

Fink-Miller and Nestler, 2018 reviewed suicide occurrence in physicians and veterinarians. They concluded that the suicide rate for women in the medical field was markedly higher than their non-healthcare counterparts. Specifically, suicide in female physicians was consistently reported to be four times that of females in the general population.

PTSD/Trauma

Rigas et al, 2023 reported findings of a systematic review of 12 articles to estimate the risk of developing secondary PTSD among paediatric health care providers as well as additional contributing factors. The prevalence of secondary PTSD ranged from 13% to 94% and one study showed higher prevalence in females. However, there was no information on the gender breakdown of cohorts, which were predominantly nurses in paediatric care, and so there may have been a majority of females included in the studies. Kendall-Tackett et al, 2022 reviewed 16 papers focused on secondary trauma or moral injury (defined as an event that violates people's moral beliefs, i.e. they have participated in, or witnessed something they could not stop, but believed was wrong) in maternity staff. They noted that secondary trauma in the healthcare workers was a significant concern affecting at least 25% of maternity staff, but that low rates in some countries corresponded to low rates of childbirth-related trauma in mothers. Secondary trauma can lead to several symptoms, including re-experiencing, avoidance, negative changes in mood and cognitions, and hyperarousal, which can cause significant impairment. As a result, many providers decide to leave the field in the wake of a patient's traumatic birth.

Hilton et al, 2022 studied factors associated with workplace PTSD in psychiatric nurses. Based on 19 studies, gender was identified as a "suggestive" factor (i.e. supported by at least one better quality study or at least two others). Evidence that women experienced PTSD to a greater extent than men was derived from one higher quality and one lower quality empirical study. However, one higher quality and six lower quality studies reported no significant association between gender and PTSD symptoms.

Trudgill et al, 2020 synthesised the evidence on the prevalence of PTSD among emergency department personnel in Canada and the USA. Findings were based on 10 surveys and showed that around one of every five such emergency care personnel met PTSD diagnostic criteria; 18.6% (95% CI: 16.9% - 20.4%). There was some suggestion, based on generally small, non-probability surveys with high non-participation rates, that PTSD prevalence is nearly two-fold greater among emergency department nurses (25.8%) than physicians (15.6%), a result which was confounded by gender. Pooled estimates of five studies supported the hypothesis that women (study samples > 90% women) were statistically significantly more likely to meet criteria for PTSD (40.1%) than men (study samples < 90% women, 18.1%).

Baum 2016 reviewed gender differences in susceptibility to secondary trauma syndrome (STS) among clinicians who treat traumatized clients, based on 10 published studies that measure STS by PTSD symptomatology and 4 studies that measured it using Stamm's Professionals Quality of Life Survey (ProQOL), which queries PTSD symptomatology along with other difficulties that may arise in helping traumatised clients. Almost all the studies based on PTSD symptomatology showed greater female susceptibility. Although the pattern was less clear in the ProQOL studies, the authors argue that the research to date does not show mixed findings, as repeatedly claimed, but greater susceptibility among female clinicians. The same author (Baum and Moyal, 2020) carried out a systematic review of 10 studies and a small-scale meta-analysis to investigate whether one gender was more susceptible than the other to the adverse effects of treating sex offenders and whether their distress was manifested similarly or differently. They concluded that the only gender difference identified was that men had a significantly higher level of vicarious traumatization.

Stress/Depression

Two reviews were identified which looked at stress and depression among healthcare workers. However, Antonino et al, 2022 was an exploratory review which was based on 7 studies among which none of the health outcomes could be specifically defined as depression (e.g. some studies included burnout). Koo et al, 2013 was not a review and did not refer to any relevant health outcomes.

Musculoskeletal disorders

Fourteen papers on MSDs within healthcare workers were identified, of which 3 were excluded as not relevant to the UK and one excluded as it was a primary study rather than a review. Although more than 5 reviews were therefore included, all are discussed in detail below, as they were carried out on different subgroups of healthcare workers.

Basager et al, 2024 investigated whether female surgeons or surgeons with smaller hand size, who use surgical instruments, had an increased risk of MSDs and discomfort compared to male or larger handed surgeons. Nineteen studies were included in the systematic review. Studies showed that around 77% of females reported musculoskeletal issues ranging from difficulty of use to pain compared to 64% of males. Female surgeons (59 to 100%) compared to male surgeons (13 to 56%) had more problems when using surgical instruments. In all included studies, the average glove size for women (6.0 to 6.5) was significantly smaller than that for males (7.0 to 8.0), which was a big factor in having difficulty in using the instruments, indicating a link between gender and hand size.

Barnard et al, 2021 investigated work-related MSDs (WMSDs) in female physicians practicing interventional and fluoroscopic procedures, including interventional radiology, interventional cardiology, electrophysiology, vascular surgery, orthopaedic surgery, neurosurgery, and gastroenterology. Based on 11 studies, the authors reported that women were generally shorter and wore smaller glove sizes than their male colleagues. Seventy-two percent of female proceduralists reported WMSDs versus 46.6% of their male colleagues and women may experience more upper extremity pain than lumbar pain, which men commonly reported. This could be due to the size and design of procedural tools and the possible predisposition of female physicians to experience upper extremity WMSDs while performing the same operations as men.

Bessone et al, 2024 compared endoscopy related injury (ERI) rates, risk factors, and ergonomic recommendations in the different endoscopic fields. A total of 46 publications were included. Female professionals had a higher risk of developing ERIs among GI and ENT endoscopists, but gender was not found to be an ERI risk factor in bronchoscopy (one survey only) and endourology. In GI endoscopy, the higher rate among female professionals has been explained by the biologically lower force that a female can generate compared to a male, and in addition, since women generally have smaller hands, they have a higher probability of being in need to adapt their position and movements to the endoscope decreasing comfort and movement efficiency and probably increasing ERI risk.

Clari et al, 2021 evaluated the prevalence of WRMSDs in perioperative nurses. Based on 22 included studies region and female sex seemed to be associated with a greater risk of lower-back problems both in nurses and in the population of operating room nurses. However, the meta-analysis carried out as part of this review did not show female sex to be a significant predictor of low back disorders. Rezaei et al, 2021 examined the prevalence of low back pain and the risk factors in hospital-based health care personnel in a systematic review and meta-analysis, with 154 studies included. The odds ratio of the relationship between female gender and low back pain was estimated to be 1.11 (95% CI: 0.99-1.24). Sun et al, 2021 aimed to systematically review and quantify the factors of NSCLBP (non-specific chronic low back pain) in nurses. Eighteen publications were included in the review and showed that being female was positively related to NSCLBP (pooled estimate OR 1.56; 95% CI: 1.24-1.96).

Lietz et al, 2018 examined the prevalence of MSDs and pain among dental professionals in Western countries, including 41 studies. However, there was no analysis or discussion of gender within the review.

Milhem et al, 2016 and Vieira et al, 2016 both reviewed prevalence and risk factors for WMSDs among physical therapists (PTs). There was some overlap between the papers included in the two reviews and so the findings are not independent. Milhem at al noted that most studies indicated that female PTs had a more increased risk of developing work-related LBP than male PTs which may be related to the fact that females are generally smaller and physically weaker than males, which may place them at a disadvantage during care tasks, particularly when lifting and transferring patients. Results from the Vieira et al review also showed that female PTs had higher rates of WMSD than male PTs: 73% (677/928) vs. 57% (529/928) in one study, and 73% (46/63) vs. 67% (12/18) in another study. Female PTs had a significantly higher rate of neck, upper back, low back, hand and wrist WMSD than their male counterparts. Another study found that female PTs were 21% more likely to have neck and upper back WMSD, and 13% more likely to have shoulder and elbow WMSD than male PTs.

Bernerdes et al, 2023 aimed to synthesize the main disorders found on nurses' ankles and feet. Their review included 38 papers and concluded that in general, female nurses were significantly more affected than male nurses ($p < .001$), reporting MSDs more frequently and presenting a higher prevalence of foot and ankle pain. Regarding body regions, one study concluded that female nurses had more knee pain (40.4%), whereas male nurses had ankle pain (68.8%) more often.

Reproductive effects

Eight reviews on reproductive health in healthcare workers were identified, two qualitative reviews were excluded.

Garcia et al, 2024 carried out a narrative review of occupational hazards and pregnancy of healthcare workers in an orthopaedic operating theatre. No details were provided of a search strategy; however, the authors note that reported infertility rates in surgeons was 32% compared to 10.9% in the general population (although it is not specified which countries this refers to) and that reported pregnancy complication rates in surgeons ranged from 25% to 35%. In the orthopaedic operating theatre occupational hazards that may influence pregnancy outcomes include radiation, exposure to methyl methacrylate in bone cement, surgical smoke, sharps injuries, exposure to anaesthetic waste gases and the effects of the physical demands of surgery including prolonged work hours and night shiftwork. Anderson and Goldman, 2020 carried out a similar narrative review and concluded that occupational hazards exist in the operating room that may be factors in increased rates of infertility and adverse pregnancy outcomes for surgeons.

Marsters et al, 2023 reviewed 42 articles related to reproductive health of physicians and healthcare workers. Results of the association between healthcare workers and physicians and risk of miscarriage were conflicting and when an increased risk was found, it was less than doubled. Two studies reported a greater prevalence of miscarriage among physicians than the general population (11.8% vs 4.2%; $p<0.001$; and 20.8% versus 14.2%; $p<0.05$) and two studies reported greater prevalence of miscarriage among healthcare workers compared with women in other occupations (OR 1.18; 95% CI: 1.13-1.23 and 1.06; 95%CI: 1.03-1.09 respectively). However, three studies comparing physicians to the general population found no difference and five studies comparing women physicians to workers in any occupation or to the partners of men physicians also reported no increased risk. Three studies including only healthcare workers reported increased risk of miscarriage with increasing work hours (healthcare workers; adjusted OR 1.36, no CI provided and nurses; relative risk 1.5; 95% CI: 1.3-1.7).

Oliveira et al, 2021 systematically evaluated whether exposure to inhalational anaesthetics was associated with abortion in a review of 18 observational studies. Some studies demonstrated a significant association between occupational exposure to inhalational anaesthetics and spontaneous abortion, especially among professionals who worked for longer periods and/or in an environment without gas scavenging/ventilation systems, which may favour the occurrence of abortion in this population. However, due to considerable heterogeneity and limitations, it cannot be concluded whether an association exists between occupational exposure to anaesthetics and the occurrence of abortion.

Warembourg et al, 2017 carried out a systematic review of occupational exposures among healthcare workers related to foetal death, congenital anomalies, and fertility disorders. Based on 32 studies, the authors reported that studies based on job title reported excess risks of some congenital anomalies (especially in the nervous and musculoskeletal systems) among healthcare workers compared to non-healthcare workers but no evidence about foetal death. There were some reports of excess risks of congenital anomalies for women exposed to anaesthetic gases. Exposure to some sterilising agents and, with less evidence, to antineoplastic drugs and to ionising radiation, was associated with increased risks of miscarriage but not stillbirth. Strenuous work schedules appeared to be associated with fertility disorders, but the evidence was limited.

Smith, 2008 examined the relationship between work and menstrual disorders among nurses. The findings suggested that workplace factors are known to be an important correlate for subjective symptoms among employed women. For example, one study found that sleep disturbances might lead to menstrual irregularities in American nurses, while another reported that American and Italian nurses with a high perceived level of work stress were more likely to have longer menstrual cycles. Among female workers in general, a relationship has been demonstrated previously between premenstrual symptoms and stress. In addition to a number of studies from Asia, an investigation of nurses from England and Wales found that working night shifts was associated with the duration of premenstrual and menstrual problems, as well as the severity of menstrual problems.

Violence/assault

Thirteen reviews on violence, physical and verbal assault and sexual harassment were identified. One full text could not be sourced and six reviews were excluded (1 non-UK, 1 case study, 1 qualitative review, 2 focus on patients, 1 focus on impact of violence on burnout). For the purposes of this umbrella review violence, assault and harassment are not relevant endpoints in themselves, however they are relevant if they are associated with subsequent ill health among those who have experienced them. The focus here is therefore on the health-related consequences of assault or harassment.

Tyau et al, 2024 carried out a narrative review of workplace violence (WPV) in healthcare workers. There were inconsistences in differences between men and women noted in the literature. Twelve studies found no difference

between women and men, seven studies found that women experienced more non-physical violence, and two studies that found women experienced more physical violence than men. One type of WPV, sexual harassment, was shown in ten studies to consistently affect women more than men. In contrast, five studies noted that male clinicians were more likely to experience non-physical WPV while 14 studies noted that men were more likely to experience physical violence than women. WPV could be perpetrated both by patients and, less frequently, by work colleagues (e.g. bullying by superiors). While most WPV was found to be non-physical, it still had significant emotional and job-related impacts on clinicians. Experience of WPV has been found to be related to symptoms of anxiety, depression, PTSD, hyper-vigilance, suspicion, burnout, distress, poor well-being, and work dissatisfaction in clinicians.

Abbott and Whitley 2023 carried out a rapid evidence review of sexual assault and harassment of ambulance personnel in the workplace. Of 7 included papers, 6 pieces of evidence from the review acknowledged that female ambulance personnel were more likely to/experienced more episodes of sexual assault and sexual harassment than males. Two studies found gender to be a statistically significant variable, with gender differences identified in levels of sexual harassment, intimidation and sexual assault. For example, one study found a difference in the proportion of female and male paramedic participants who had experienced sexual harassment (37.7 % vs 9.5 %, respectively) and sexual assault (11.5 % vs 1.6 %, respectively). It was also noted that the effect of sexual harassment and assault in the workplace had a negative impact on victims including change in sleep pattern, and depressive symptoms. Perpetrators varied between studies. One study stated that although sexual harassment was perpetrated by patients, families and colleagues; sexual assault was most often perpetrated by patients, often in the back of the ambulance, while another study noted that perpetrators can be colleagues, families, patients, but also bystanders, other service colleagues or hospital staff.

Rossi et al, 2023 carried out an umbrella review of systematic reviews and meta-analyses to address workplace violence against healthcare workers. A total of 32 systematic reviews were included, 19 of which performed a meta-analysis. Overall, violence prevalence among healthcare workers was reported to be as high as 78.9%, and nurses working in psychiatric wards were the professionals most impacted. Some of the included reviews found a greater incidence of violence in the female gender, whereas others claimed a higher prevalence of violence in the male gender. No specific data were provided on the types of perpetrators of WPV. Consequences of WPV may include anxiety, depression, PTSD, and other adverse mental health conditions.

Smith et al, 2023 reported an integrative review which aimed to build a temporal understanding of nursing students' experiences of sexual harassment whilst on clinical placement, and to discuss the social context which enabled this. A synthesis of 26 papers demonstrated that sexual harassment had significant impacts on student nurses and the nursing profession, with consequences including psychological impacts, as well as physical effects such as headaches, nausea, general fatigue and sleep disturbances. Perpetrators were predominantly male (75–98%) and predominantly patients, typically followed by family/friends and physicians.

Kahsay et al, 2020 also examined the prevalence of sexual harassment against female nurses, including its health consequences. The prevalence of sexual harassment against female nurses was 43.15% (range 10 to 87.3%). Perpetrators most commonly included patients (47%), followed by physicians (41%), patients' family (28%), nurses (20%) and other coworkers (18%). The review indicated that sexual harassment against the female nurses led them to have physical health consequences manifested in the form of headache, exhaustion, gastritis, nausea or vomiting, weight gain or weight loss, and neuromuscular problems such as muscle pain or convulsion and dizziness. In addition, the female nurses had other physical manifestation with sleeping difficulty, inability to sleep, or abnormally long sleep.

Edward et al, 2016 investigated factors related to aggression (verbal abuse or physical abuse/assault) perpetrated against the nurse or other health professionals by patients/relatives or staff. Based on 14 papers, a higher proportion of female nurses than male nurses was reported to be the victims of verbal abuse, with the difference in proportions being statistically significant (OR 1.21; 95% CI: 1.05-1.40). A statistically significant higher proportion of male nurses than female nurses were reported to be the victims of physical abuse. A significantly higher proportion of mental health nurses reported experiencing physical abuse as compared to non-mental health nurses. There was no information provided on the health impacts of the physical or verbal abuse.

Other/general health outcomes

Twenty three reviews on other or general health outcomes were identified. Two full texts were not available, and 15 reviews were excluded (2 non-UK relevant, 2 not in English, 2 on injuries, 1 on quality of life, 1 not a review, 1 on emotional impact, 1 focus on fatigue, 1 on war zones, 1 on burnout, 1 not occupational, 1 focus on sedentary behaviour).

The remaining six reviews included three on shiftwork (specifically in healthcare workers) and its association with metabolic syndrome and obesity, and one each on cytomegalovirus (CMV), physical health and occupational risk factors in emergency service workers.

Yang et al, 2021 examined the association of shiftwork with risk of metabolic syndrome (MetS) through a systematic review and meta-analysis which included 23 articles covering 38 studies. The meta-analysis suggested that shiftwork increased risk of MetS. Higher risk of MetS was found in the shiftworkers who were 2-shift or 3-shift or women or Asian workers. The RR for men was 1.23 (95% CI: 1.07-1.42), and for women was 1.61 (95% CI: 1.26-2.06). Rosa et al, 2020 aimed to describe the effects of shiftwork on metabolic syndrome and urolithiasis in nurses. Seven articles were analysed, but the paper focused on associations between metabolic syndrome and urolithiasis and did not look explicitly at associations with shiftwork.

Zhang et al, 2020 investigated the association of shiftwork and the risk of obesity in nurses. Based on 11 eligible studies, the pooled estimate obesity risk in shiftwork nurses compared to non-shiftwork nurses was not statistically significant (OR 1.05; 95% CI: 0.97–1.14). However, the risk of obesity was significantly higher in the sub-analysis of night-only shiftwork nurses (OR 1.12, 95% CI: 1.03–1.21). In a sub-analysis limited only to the studies of female nurses, the obesity risk was found not to be statistically significant (OR 1.09; 95% CI: 0.84–1.35). The BMI cut-off for obesity varied in the included studies. When using a cut-off of BMI ≥ 30 kg/m^2 for obesity, the subgroup analysis showed a positive relationship between obesity and night shift work (OR 1.12; 95% CI: 1.03–1.20).

Balegamire et al, 2022 carried out a review to determine CMV seroprevalence, incidence of primary infection, and associated risk factors in healthcare and childcare workers. Forty-eight articles were included in this meta-analysis. Pooled CMV seroprevalence was 59.3% (95% CI: 49.8-68.6) among childcare workers and 49.5% (95% CI: 40.3-58.7) among healthcare workers. The RRs for primary infection compared to controls were 3.4 (95% CI: 1.3-8.8) and 1.3 (95% CI: 0.6-2.7) for healthcare and childcare workers, respectively. The odds of CMV seropositivity were 1.6 (95% CI: 1.2-2.3) times higher for childcare workers compared to controls, but not significantly different between healthcare workers and controls (0.9; 95% CI: 0.6-1.2). The authors noted that the significance of the higher risk of CMV primary infection in childcare workers compared to controls should be regarded with some caution because for controls, the risk was derived from the unadjusted analysis of only three studies, and major confounders, particularly age, socioeconomic status, and number of children living at home, were not considered.

Fronteira and Ferrinho, 2011 systematically reviewed the evidence on nurses' physical health, including 187 studies. They concluded that nurses were at greater risk of musculoskeletal injuries, consistent with the nature of nursing work, and more prone to blood-borne pathogens infections than other healthcare workers. They were at greater risk of breast cancer than other female healthcare workers. Nurses in hospitals were more at risk of tuberculosis, particularly if they worked in pulmonary, medicine or HIV wards. They did not have excess risk of cancer in general, Hodgkin's disease, stomach, colon, rectum, pancreatic, ovary, kidney, brain or thyroid cancer or of lymphosarcoma. They had a higher prevalence of occupational allergies than clerical workers, probably due to exposure to a series of chemical agents.

Donnelly and Siebert 2009 investigated occupational hazards in US based emergency medical technicians (EMTs). Exposure to traumatic events was reported to be between 80% and 100% among EMTs, and rates of PTSD were >20%. High-risk alcohol and drug use rates among other emergency response professionals were reported to be as high as 40%. The focus of the review was on linkages between occupationally related stress exposure and high-risk alcohol and other drug use and did not consider gender differences.

3.2.8 Hospitality workers

Three reviews on adverse mental health among hospitality workers were identified. All of these were excluded, one was focused on burnout, one was on emotional labour rather than a health outcome and one was not a full text and was not available in English. A further review on the hospitality industry (specifically casino workers) was excluded due to a focus on exposures and working conditions rather than health and one review on sexual harassment in the casino gaming industry was excluded as it did not address health consequences.

3.2.9 Office workers

Seven reviews of the health of office workers were identified, three on MSDs (Demissie et al, 2024; Paksaichol et al 2012; Azcan et al, 2011) and four on impacts of air quality in offices (Gupta et al, 2023; Reitmayer et al, 2023; Wolkoff,

2020; Nezis, 2019). One of the mental health reviews could not be sourced and one of the air quality reviews was excluded as it was not relevant to the UK.

Demissie et al, 2024 reviewed 25 cross-sectional studies on MSDs among computer users within offices. All except one study were from Asian and African countries and so the results may not be transferable to the UK. The remaining study was carried out in Estonia. Prevalence of MSDs was high and eight of the studies reported that women were more likely to develop MSDs than men. However, the review was not of particularly high quality, and taking this together with the geographical areas included suggests that it does not contribute materially to the current umbrella review. Paksaichol et al, 2012 reviewed five high-quality and two low-quality prospective cohort studies investigating the predictive value of 47 individual, work-related physical and work-related psychosocial factors for the onset of non-specific neck pain in office workers. All four of the studies which studied gender found a significant association between gender and onset of neck pain, with ORs for females of 1.21 (95% CI: 1.16, 1.27), 1.9 (95% CI: 1.1, 3.3), and 2.9 (95% CI: 1.3, 6.7), and a hazard ratio of 3.07 (95% CI: 1.18, 7.99), all based on multivariable analyses.

Reitmayer et al, 2023 carried out a scoping review of 16 studies of human physiological responses to time-dependent and dynamic temperature exposure in indoor office environments with a focus on the effects on the health and well-being of workers. They concluded that, due to inconsistent experimental designs and research foci across these studies, relationships with health outcomes could not be established. No investigation of differences between genders was conducted, and several of the studies included were in countries such as China (6 studies) where the results may not be relevant to the UK. Wolkoff, 2020 investigated trends over time in dry eye symptoms associated with dry air in office environments and the association between dry eye symptoms, perceived dry air and deteriorated office work performance. Prevalence of reported dry eye syndrome was about 20–40%, retrospectively, in European offices. The review provides information on the environmental (climatic), occupational, and personal risk factors, which alter the stability of the precorneal tear film, essential for ocular surface health and ocular comfort, but does not explicitly consider gender differences.

Nezis et al, 2019 focused on measurements of levels of exposure to particulate matter (PM) and other indoor air pollutants (IAPs) in office environments. However, they also reviewed nine studies that used self-reported questionnaires to assess sick building syndrome (SBS) related symptoms in office workers caused by exposure to PM10, PM2.5 (PM with diameter < 10µm and <2.5µm respectively) and other pollutants. Associations were found between exposure to IAPs and self-reported symptoms and the authors also noted that there needs to be consideration of the differences between the two genders with regards to perceived SBS symptoms, exposures, and other psychosocial factors, since many studies found significant differences between males and females and reported SBS symptoms. However, the findings in relation to gender were not consistent between studies with some finding higher reporting of symptoms among males, and others finding higher symptom reporting among females.

3.2.10 Scientists

Two reviews were identified for workers in the scientific industry. One of these was on adverse mental health (Trang et al, 2024) and was a questionnaire survey of adverse mental health among around 300 scientists in the planetary science field rather than a review. The study found that participants who identified as male reported overall better mental health than participants who identified as female. Anxiety scores were higher among female respondents than male respondents (GAD-7, p = .003; DASS-42-anxiety, p = .011) as were stress scores (DASS-42-stress, p = .037). There were no differences in terms of depression.

The second review paper (Roper, 2019) addressed the issue of gender bias in science but did not include information on health and so was excluded from this scoping review.

3.2.11 Social workers

Two reviews of adverse mental health among social workers were identified (Padan et al, 2021; Collins, 2008). Padan et al was excluded as the full text was unavailable and it was clear from the title and abstract that the focus was on burnout. Collins examined the satisfaction social workers feel about their work, considered healthy and unhealthy coping strategies that are, and might be, used, gender differences and the importance of various forms of support from within the work setting. This was a narrative review, which did not investigate health outcomes, but rather methods to mitigate stress through various support mechanisms.

3.2.12 Teachers

Twelve reviews on adverse mental health in teachers were identified of which nine were excluded. These comprised 1 duplicate paper within the spreadsheet, 4 studies focusing on burnout, 1 study focusing on emotional management and 3 non-UK relevant studies.

Pinho et al, 2023 carried out a review to investigate and critically evaluate the scientific evidence regarding occupational stress and adverse mental health among higher education teachers from a gender perspective. Thirty-six studies were included in the review, of which around 40% were from Brazil and 25% from Asia, and 26 of these did not investigate gender differences. Eight of the remaining 10 studies were assessed by the authors to only consider gender disparities in a 'partial sense', looking only descriptively at differences, with several of these studies reporting higher prevalences of a range of adverse mental health outcomes in women. The final two studies carried out gender analysis with signs of disparity between men and women in teaching in the United Kingdom and Croatia. Women were more dissatisfied than men, but the latter had higher frequencies of mental illness. Corrente et al 2022 carried out a scoping review comprising 61 articles on teacher's mental health problems, leaves of absences, and return-to-work. The study did not focus on gender differences in adverse mental health outcomes but noted that return to work strategies that recognize the influence of gender on this process may benefit female teachers who are struggling with care work outside the workplace and could use additional support strategies.

The full text for Trevisan et al 2022 could not be sourced, however the abstract noted that the study aimed to characterize the epidemiological profile of mental health problems in teachers at national and international levels, and based on 28 articles, the results indicated that work overload was a psychosocial risk factor and that the teachers who were vulnerable to illness were female, single, with high levels of formal education and a family history of mental disorders.

Two reviews of MSDs in teachers were found, of which one was excluded as it was not thought to be relevant to the UK. Erick et al 2011 carried out a review of 33 papers to investigate the prevalence and risk factors for MSDs among teaching staff. The authors noted that from the reviewed literature, it appeared that the prevalence of MSDs was generally high among teaching staff and prevalence and severity of MSDs was positively associated with female gender, quoting findings from a number of studies from China, Turkey, Sweden and Australia. They hypothesised that this may be because women might be more likely to report pain than men because women have lower physical strength, pressure from family and career prospects; or simply the fact that men and women have different traditions and thresholds for when and how they report pain.

Two other reviews on teachers' health were identified. One of these was not in English and so excluded from this scoping review (Bortkiewicz et al, 2020). Examination of the English abstract of this paper showed that only a few studies of health and lifestyle were identified among teachers in Poland, and these used different methods and were generally of small groups. Byeon, 2019 carried out a review of voice disorders in teachers, which included 16 studies, 6 classified as 'strong' quality and 10 classified as 'good' quality. The meta-analysis showed that gender (OR for females vs males 1.60; 95% CI: 1.27-2.01), upper airway problems, caffeine consumption, speaking loudly, number of classes per week, and resignation experience due to voice problems were the major risk factors of teachers' voice disorders. They concluded that, although voice problems are perceived differently by gender, women might be more vulnerable to voice disorders.

One review on violence/assault in teachers was found. Henning et al, 2017 reviewed the literature on workplace harassment in higher education, including 51 studies (mainly from North America). They found that the most common cause for harassment was discrimination based on gender differences e.g. one study reported that women and in particular minority women were exposed to unfair treatment in higher education settings, often being burdened with large teaching workloads. They also noted some evidence of links between harassment and abuse with depression, anxiety, and hostility, with women more likely to experience adverse consequences compared to men. Other consequences reported included headaches, loss of confidence, loss of self-esteem, fatigue/listlessness, and PTSD.

3.2.13 Other occupations

There were a substantial number of reviews identified which were either specific to an occupation not specified above, or did not specify any particular occupational group. These are described by health outcome below.

Mental health

Thirty-two reviews of adverse mental health were identified, of which one full paper could not be sourced and 26 were excluded (11 on burnout/stress, 1 on sex workers, 4 on veterans, 2 on wellbeing, 5 non-health outcomes, 1 not a review, 1 not in English, 1 not occupational, 1 not employed workers).

Mellbye and Carter, 2017 considered evidence on the frequency of and trends in depression and suicide among seafarers. Women make up about 1–2% of the world's total seafaring population, and the health effects they suffer most frequently are back/joint pain followed by anxiety, stress and depression. Women seafarers also report gender related discrimination, ranging from distorted expectations of their work capacity to outright sexual harassment. No quantification of health outcomes in women was provided in the paper.

Cabezas-Rodriguez et al, 2021 investigated the role of working and labour conditions, domestic work and caregiving and social support in gender inequalities on adverse mental health. Based on 30 articles, the authors concluded that the adverse mental health in men was seen to be more influenced by employment conditions and that in women by working conditions and the need to respond simultaneously to the demands of paid and domestic-family work. Based on the data from studies analysed, rates of psychological distress and mental health diagnoses are higher in women than in men consistent with patterns in the general scientific literature in this field.

Milner et al, 2021 sought to understand gender differences in adverse mental health outcomes in relation to the components of gendered working environments[5]. Across the 27 cohort studies included in the review, they found that there was inconclusive evidence on the effect of occupational gender composition on the adverse mental health of men and women, although women's mental health was more likely to be adversely affected by long working hours than men's. They concluded that gendered working environments may adversely affect the mental health of both men and women, but the association is dependent on the specific exposure examined.

Watanabe et al, 2016 investigated whether working beyond the standard working hours was associated with a greater risk of depressive disorder among workers, based on 7 studies. Only one study (based on data from the National Population Health Survey (NPHS) in Canada) reported the association between overtime work and depressive disorder for women (RR=2.20), which was greater than the association for men in the same study (RR=0.60). Suggested reasons for the greater effect of overtime work on adverse mental health in women included that women are more likely to have household and other family responsibilities than men, and thus less time to recover from the effects of overtime work, and that overtime work might lead to work–family conflicts and depressive disorder in women.

Musculoskeletal disorders

Nine reviews of MSDs were found, of which 3 were excluded (1 not UK relevant, 1 not in English, 1 non-occupational).

Greggi et al, 2024 investigated the impact that different work-related activities have on the musculoskeletal system, based on 32 studies. In the healthcare sector, the prevalence estimate for degenerative diseases of the lumbar spine was 21% (497 out of 2547 physicians and dentists) (95% CI: 17-26%), while for osteoarthritis of the hand, it was 37% (382 out of 1013 dentists) (95% CI: 23-51%). Gender differences were not considered in this review.

MacDonald et al, 2024 examined associations between occupational lifting or postural load in pregnancy and associated MSDs based on 16 studies. There was limited but consistent evidence suggesting that pregnant workers exposed to heavy lifting (usually defined as ≥ 22 lbs or ≥ 10 kg) may be at increased risk of functionally limiting pelvic girdle pain and antenatal leave, with some evidence of a dose-response relationship according to lifting frequency.

Ferguson et al, 2019 evaluated the prevalence and risk factors for wrist pain in 32 cross sectional studies. They concluded that wrist pain is highly prevalent in groups who partake in physically demanding activities from day to day such as manual labourers and sportspeople, while it is less prevalent in the general population and non-manual workers. One general population study showed that the frequency of wrist pain was 14.7% (95% CI: 13.6–15.8%) in women, higher

[5] Gendered working environments are defined in the review as the range of gendered exposures related to: (1) selection into work (e.g., entry into a first job); (2) variation in employment arrangements and working hours, including 'flexible' or precarious employment, underemployment and long working hours, and temporary absence from work due to sick leave, parental leave, and so on; (3) differences in psychosocial exposures at work including exposure to low control and high demands, and (4) potentially gendered differences in selection out of work, such as unemployment or retirement.

than in men 5.6% (95% CI 4.9–6.3%); however no odds or risk ratio was provided, while a second study found a higher prevalence of wrist pain in female dental students but provided no further data relating to the strength of this association.

Charles et al, 2018 summarised the evidence linking occupational exposures to vibration and awkward posture with MSDs of the shoulder and neck. Occupational exposures to whole-body or hand-arm vibration were significantly associated with or resulted in MSDs of the shoulder and neck. Awkward postures while working were also associated with MSDs in these locations. However, there was no analysis of gender differences in this narrative review.

Hooftman et al, 2004 examined gender differences in risk factors and musculoskeletal complaints. The results showed evidence of a gender difference for a few risk factors but in most cases, men had the higher risk (e.g. for lifting and back issues and hand-arm vibration and neck-shoulder complaints). The exception was for the association of arm posture and neck-shoulder complaints where there was strong evidence that women had a higher risk than men. The authors noted that some of these gender differences may be due to different numbers of workers exposed or different exposures within the same exposure category.

Das et al, 2020 evaluated the prevalence of WMSDs and associated risk factors among handicraft workers, based on 30 papers. Risk factors included working posture, daily working hours, repetitive and forceful movements, work experience, age, gender and working under stressful conditions. Several studies reported that female craft workers were at a higher risk of developing musculoskeletal symptoms in the neck compared to male workers with ORs across three studies ranging from 1.82 (95% CI: 1.10-3.02) to 3.38 (95% CI: 1.13-10.14), particularly for neck and shoulder symptoms.

Reproductive health

Twenty-six reviews on reproductive health were identified. One full text could not be sourced and 8 were excluded (1 animal study, 5 not occupational, 1 not UK relevant, 1 on veterans, 1 on birth effects only).

Razafimahefa et al, 2022 investigated occupational factors that influence women's sexual reproductive health (SRH) outcomes in the oil, gas and mining (OGM) industry. Based on 16 articles, they found that chemical and physical agents are the predominant factors influencing women workers' SRH outcomes, with most studies showing menstrual and cycle disorders, and risky pregnancy as key SRH issues. Nine studies showed chemical factors including organic and inorganic solvents and heavy metals, toxic gases and dusts affected female workers' sexual and reproductive health status. Physical factors associated with sexual and reproductive health among female workers in OGM industry were also identified in eight papers which showed that menstruation and cycle disorders and risky pregnancy could be triggered by physical factors (e.g. underground mining hot or cold environments, noise and vibration, mechanical shocks, physical strain, and male-designed tools and equipment). Physical factors influencing menstruation disorders and miscarriages in the petrochemical industry were physical exertion and fatigue, caused by strenuous activities, prolonged standing, long working shifts, heavy equipment vibration and underground heat stress.

Kim et al, 2019 examined the association between semiconductor work and specific processes and spontaneous abortion (SA) based on a meta-analysis of six studies. During 1980-1993, the risk of SA in fabrication (Fab) workers was significantly higher than non-Fab workers (RR 1.29; 95% CI: 1.05-1.57). Photolithography workers had a higher SA risk than non-process and office workers (RR 1.41; 95% CI: 1.13-1.77).

Adane et al, 2023 reviewed the evidence on the relationship between physical occupational risks and preterm birth. Based on 37 studies, moderate evidence was found of positive associations between high physical workload, long working hours, shiftwork, whole-body vibration, and preterm birth. Meta-analysis showed a 44% higher risk (OR 1.44; 95% CI: 1.25-1.66) for preterm birth with long working hours and a 63% higher risk (OR 1.63; 95% CI: 1.03-2.58) with shiftwork. Occupational information was typically collected by telephone interview and no information was provided of the specific occupations of the study groups.

Corchero-Falcan et al, 2023 assessed the risk factors perceived as stressors by pregnant women in the work environment and possible adverse consequences. A total of 38 studies was included and the main risk factors were found to be chemical, psychosocial, and physical-ergonomic-mechanical factors. In particular, the authors noted that exposure to particles such as iron, benzene or ethylene oxide can be associated with low birth weight, miscarriage, risk of preterm birth, and pregnancy loss, while physically demanding occupational conditions, lifting heavy loads during pregnancy and strenuous positions in early pregnancy increase the risk of pre-eclampsia, low birth weight babies, and preterm birth.

Frangione et al, 2023 examined research into the association of maternal and paternal exposure to low-dose radiation with low birth weight, miscarriage, pre-term delivery, and stillbirth. Based on 26 studies, the authors reported measures of association from 10, 11, and 8 studies for low birth weight, miscarriage, and stillbirth outcomes, respectively. The meta-analysis summary relative risk (RR) of having a low-birth-weight infant among those ever exposed to radiation relative to those unexposed was 1.29 (95% CI: 0.97-1.73). The corresponding risk estimates for miscarriage and stillbirth were 1.15 (95% CI: 1.02-1.30), and 1.19 (95% CI: 0.98-1.45), respectively. However, not all the studies were based on occupational exposure to radiation, and no distinction was made between occupational and non-occupational sources in the analysis.

Kumar, 2011 examined a wide range of factors (including organochlorine chemicals such as dichlorodiphenyl trichloroethane (DDT); metals such as lead, mercury; industrial pollutants such as dioxin, organic solvents, radiations) in relation to adverse pregnancy outcomes. They concluded that the existing data support the hypothesis that, in general, working women have a higher risk of undesirable reproductive outcomes, even though the data are sparse. For example, exposure to some agricultural chemicals, solvents and radiation are associated with a range of adverse outcomes.

Li et al, 2023 investigated the association between maternal cadmium (Cd) exposure and preeclampsia in 17 studies with 10,373 participants. They found a significant association between maternal cadmium exposure and the risk of preeclampsia (Standardised Mean Difference 0.27; 95% CI: 0.09-0.44; $p < 0.01$) suggesting that maternal blood cadmium levels (but not urine or placental levels) were associated with an increased risk of preeclampsia.

Ramezanifar et al, 2023 reviewed the pathophysiological effects of occupational physical and chemical risk factors on the reproductive system of females and males. They included 43 field studies. Physical (noise, heat, and radiofrequency radiation) and chemical (such as carbamate and organophosphate pesticides, benzene, toluene, xylene, formaldehyde, NO2, CS2, manganese, lead, nickel, and n-hexane) risk factors had pathophysiological effects on the human reproductive system in a range of different outcomes (see Tables 1 and 2 of the paper for details).

Suaidi et al, 2022 investigated the toxic effects of xylene on menstruation, endocrine endpoints, fetal development, and reproductive functions, based on 22 papers. From human studies, it was concluded that xylene affects menstruation by prolonging its cycle, evidenced from studies of occupational exposure of organic solvents in petroleum and chemical processing plants and BTEX compounds in confined spaces such as beauty salons. Exposure to xylene in these smaller occupational settings was also found to cause menstrual disturbances with other health problems amongst female workers, e.g., skin irritations, headaches, and increased heart rate.

Martelli et al, 2021 investigated the effect of occupational factors on andropause and menopause, based on 8 studies of age at menopause onset, and 9 studies of effects on menopausal symptoms. In women, a correlation was described among high job strain, repetitive work and early menopause onset and menopausal symptom severity. Sleep disorders seemed to affect hormone levels, suggesting that, in women, shiftwork can modify circadian rhythms and affect hormone synthesis.

Croteau, 2020 examined the effect of lifting at work on pregnancy outcome, focusing on specific exposure categories. Based on 51 articles, they reported that heavy (≥ 10 kg) loads often (≥ 10x/day) lifted were associated with increased risks of spontaneous abortion (SA) (summary risk estimate (RE) 1.31; 95% CI: 1.17-1.47) and pre-term delivery (PTD) (summary RE 1.24; 95% CI: 1.07-1.43), with good strength of evidence. No association was identified with small for gestational age (SGA), nor with lower exposure levels and SA or PTD.

Sati, 2020, reviewed the evidence regarding potential effects of chronodisruption (disturbance of the body's natural biological clock) on both female and male reproductive systems and found evidence that shiftwork during pregnancy increased the risk for poor pregnancy outcomes such as small offspring, miscarriage and preterm birth, but there were also reports demonstrating the suggested risk associated with shiftwork was small. The authors noted that most of the studies in this research area investigating maternal shift work and its long-term health consequences suffered from small sample size, and non-standardized type and timing of night shiftwork.

Figa-Talamanca et al, 2006 examined the evidence on the relationship between occupational exposures and negative reproductive outcome among women workers. They concluded that the evidence was sufficient to warrant the maximum protection of pregnant women to several well-documented occupational risk factors including anaesthetic gases, antineoplastic drugs, heavy metals, solvents, heavy physical work and irregular work schedules. For other work

risks, such as exposure to non-ionizing radiation and psychosocial work stress, the evidence was often suggestive but not conclusive.

Winker and Radiger, 2006 investigated the adverse effects of occupational factors on fertility, developmental effects and genetic changes in the germ line, which lead to genetic malformations or to genetic disease. The collected studies suggested that the exposure to lead, organic mercury compounds, manganese, carbon disulfide, 2-bromopropane and dibromochloropropane, welding, professional driving and working with heat may adversely affect fertility.

Sieja et al, 2018 examined female reproductive health hazards amongst women chronically exposed to Carbon Disulfide (CS2) in their workplace in the viscose industry. The authors noted that CS2 may lead to spontaneous abortion and very early pregnancy loss among women exposed in the workplace, but that the mechanism remains unclear. Some studies showed that the rate of very early pregnancy loss was 48.7% in the CS2-exposed group as compared with 26.3% in the control group, indicating that the period of early embryo development was sensitive to CS2-exposure. Other effects reported included that, among CS2 exposed women, menstrual disorders were more frequent, and the average menopausal age was earlier.

Spadarella et al, 2021 tested the hypothesis that occupational factors would impact the risk for hypertensive disorders in pregnancy (HDP), including gestational hypertension (GH) and pre-eclampsia (PE) in pregnant workers, based on 27 studies. The main conclusions of the study were that biological risks had not been sufficiently explored in workplace settings, while for chemical risk factors, the few studies available in the literature gave inconclusive results. Concerning physical risk factors, the data did not provide conclusive information on the correlation of workplace noise exposure and HDP. However, a significant positive association was described with higher occupational noise levels between 80 and 85 dB(A) particularly in co-exposure with night shiftwork. No sufficient information was currently available on the role of extreme temperature and vibration exposure in determining HDP, with only one study showing a statistical association between exposure to WBV and the risk of HDP. Several studies confirmed the lack of association between shiftwork and HDP, however some authors demonstrated a possible positive correlation, taking into account different confounding variables, such as BMI and parity.

Violence/assault

Ten reviews were found on violence/assault or harassment, of which 9 were excluded (7 not health, 1 not UK relevant, 1 not occupational).

Blindow et al, 2024 examined the prospective associations of work-related gender-based violence and harassment (GBVH) with people's health and occupational situation. The review included 29 papers, of which only two studies investigated non-sexual kinds of GBVH. The review considered the association of sexual violence and harassment (SVH) with physical health and concluded that, based on 2 papers, there was a weak, statistically significant association with hypertension. Thirteen papers studied SVH and mental health from which the authors concluded that studies with continuous outcomes of depressive symptoms (generally defined using validated questionnaires) showed weak associations, while studies using cutoffs for treatment-relevant symptom levels and register-based outcomes of mental health treatment, self-directed violence and suicide (attempts) showed mostly moderate or strong associations.

Other/general health outcomes

Thirty-seven reviews on other health outcomes were identified. Two full texts could not be sourced and 22 other reviews were excluded (6 on sex workers, 2 on veterans/military, 1 on spaceflight, 2 not occupational, 4 not health, 1 on injuries, 1 model development, 1 on blood pressure measurements, 1 not UK relevant, 1 narrative review).

Oza et al, 2022 carried out a systematic review to identify occupational risk factors among sanitation workers in 65 studies (9 cohort studies, 56 cross-sectional studies). The results suggested that sanitation workers were at increased risk of gastroenteritis and respiratory conditions, and may be at increased risk of MSDs, mental/social health conditions and hepatitis A. However, this was based on studies of primarily male workers and no analysis was carried out by gender.

Elser et al, 2018 reviewed blue-collar women's health based on 177 studies that considered a wide range of health outcomes, with the two most commonly studied outcomes being musculoskeletal disorders (N = 30, 16.9%), followed by all-cause and cause-specific mortality (N = 20, 11.3%) and cardiovascular diseases (N = 19, 10.7%). Key results included that studies on MSDs consistently showed increased risk for pain and work-related injuries in blue-collar women as compared with men, while similarly, blue-collar women exhibited inferior respiratory health compared with blue-collar men based on results from pulmonary function tests and airway responsiveness. Studies also reported

increased risk for various MSDs, cardiovascular disorders and adverse pregnancy-related outcomes in blue-collar women as compared with women in other occupations and job types.

Yoo et al, 2023 aimed to identify the various occupational risk factors for lower urinary tract symptoms (LUTS) among female workers, based on 16 articles. The occupational risk factors identified in the studies were strenuous physical demand and activity, prolonged sitting, occupational stress, shiftwork, limited use of the toilet at work and other occupational environments (e.g., an unclean and uncomfortable workplace, dangerous job and probability of accidents, feeling pressed for time and awkward position for long periods). Similarly, Markland et al, 2018 examined LUTS by occupation as an indirect measure of infrequent voiding behaviours. Urinary incontinence (UI) was reported in 30 studies, overactive bladder (OAB) in 6 studies, and urinary tract infections (UTIs) in 2 studies. In the small number of studies conducted, women in manual occupations had increased rates of UI and OAB compared to unemployed women or women in non-manual occupations. Women with OAB and UI were also more likely to modify their behaviours in the workplace by decreasing voiding and fluid intake, have decreased work productivity, and were at increased risk for disability.

Jamil et al, 2022 reviewed the association between occupational exposures and incidence rate of hand eczema in 15 studies. Hairdressers had a high incidence of hand eczema with an incidence rate per 100 person-years (IR) of 21.4 (95% CI: 15.3-27.4), as did nurses (IR 16.9; 95% CI: 11.2-22.7), and metal workers (IR 12.4; 95% CI: 3.5-21.3). Hairdressers were predominantly women, and metal workers were predominantly men. Office occupations had an IR of hand eczema of 4.9 (95% CI: 1.2-9.6). Amado and Taylor, 2006 reviewed dermatologic issues in female-dominated occupations in health care and cosmetology. The authors noted that occupational contact dermatitis is a common problem in nurses, who are exposed to a wide variety of irritants and allergens, for example in a study conducted in 44 nurses with hand dermatitis (40 female), irritant contact dermatitis (ICD) was found to be occupationally relevant in 23% of the cases, and allergic contact dermatitis (ACD) was relevant in 18%. Dental assistants, the majority of whom are female also report occupational skin diseases, potentially due to frequent hand washing and exposure to detergents and disinfectants and glove use causing irritant dermatitis. Among hairdressers, frequent exposure to water, detergents, hair dyes and bleaches, alkaline and acid permanent waves, metal equipment, and frictional forces can also lead to the development of hand dermatitis.

Reichel et al, 2022 investigated the association between sedentary occupations and heart health and obesity. Eleven of 27 publications reported sex-stratified findings and five of these found sex differences. Associations of occupational sitting with mortality and acute myocardial infarction in females were found in three studies, with myocardial infarction in both sexes in one study and with BMI change in females in one study. Six publications found no differences in risks between women and men. Wu et al, 2022 examined dose-response associations between sedentary time and the risk of metabolic syndrome (MetS) in 26 papers. In categorical analyses, both intermediate (median duration: 4.11 h/day; pooled OR: 1.17; 95% CI: 1.08-1.26) and high levels (median duration: 7.26 h/day; pooled OR: 1.71; 95% CI: 1.43-2.04) of total sedentary time were significantly associated with an increased risk of metabolic syndrome. Similarly, a significant association between screen time and the risk of metabolic syndrome was also found in intermediate (median duration: 2.22 h/day; pooled OR: 1.20; 95% CI: 1.10-1.32) and high levels (median duration: 3.40 h/day; pooled OR: 1.63; 95% CI: 1.44-1.86) of exposure. Of note, these associations were significantly stronger in women, for example compared with the lowest category, a significantly increased risk of MetS associated with the intermediate category of screen time was only observed in women (pooled OR: 1.26; 95% CI: 1.06–1.50) but not men (pooled OR: 1.14; 95% CI: 0.97–1.33). The risk of MetS associated with the highest category of screen time in women (pooled OR: 1.87; 95% CI: 1.49–2.34) was significantly higher than men (pooled OR: 1.51; 95% CI: 1.28–1.77).

Idris et al, 2021 aimed to identify the prevalence of non-communicable diseases (NCDs) and associated risk factors among working women, based on 12 articles. Prevalence of NCDs was as follows: coronary heart disease, 0.3%-5.9%; metabolic syndrome, 52.0%; diabetes mellitus, 8.9%-16.0%; hypertension, 16.6%-66.4%; non-skin cancer, 3.7%. The prevalence of NCD risk factors was as follows: overweight/obesity, 33.8%-77.0%; low physical activity, 51.0%; unhealthy diet, 44.9%-69.9%; dyslipidemia, 27.8%-44.0%. The factors associated with NCDs were long working hours, double work burden, and stress.

Talens-Estarelles et al, 2021 examined the association between digital display use and dry eye disease (DED), by examining occurrence of ocular surface alterations in relation to screen use, in both occupational and non-occupational settings. Separate results were not reported for occupational exposure. The authors noted that female gender is widely accepted as a risk factor for the development of DED, with differences in DED rates between women and men tending to become significant only with increasing age but this was not attributed to occupational exposure.

Amiri et al, 2020 examined the effects of job strain on mortality risk based on 17 longitudinal studies The risk ratio (RR) of mortality based on job strain was 1.20 (95% CI: 1.04-1.37). In men, the RR is 1.21 (95% CI: 1.02-1.44) and in women, the RR is 0.97 (95% CI: 0.84-1.12). The authors commented that, in explaining the sex differences, several issues should be noted, specifically that the fact that men are more likely to be at risk of mortality owing to job strain can be attributed to the fact that men have lower life expectancy than women and also that it has also been shown that men and women respond differently to job demands.

Foster et al, 2020 aimed to examine the role of individual characteristics on the human heat stress response, specifically in relation to hyperthermia risk and productivity loss in hot workplaces. They reported that the relevance of any factor was dynamic, based on the work-type (fixed pace or relative to fitness level), work intensity (low, moderate, or heavy work), climate type (humidity, clothing vapor resistance), and variable of interest (risk of hyperthermia or likelihood of productivity loss). Sex has a moderate impact on the heat stress response which becomes minor if body characteristics and fitness factors are accounted for. The impact of sex on hyperthermia and work capacity are mostly relevant during heavy work in compensable environments. Compared with men of equal fitness and body composition, women may have a higher HR and reduced capacity for sweat evaporation at heavy workloads, but the differences disappear if both groups are heat acclimated.

Dzhambov and Dimitrova, 2016 carried out a review and meta-analysis of the risks of IHD morbidity and mortality because of occupational noise exposure. Out of four studies, a higher mortality risk was suggested by one moderate quality study relying on self-rated exposure and one of high-quality study using objective exposure. Sensitivity analyses showed that women seemed to be more adversely affected by occupational noise than men. One study reported ORs of 1.24 (95% CI: 0.91-1.69) and 1.22 (95% CI: 0.34-4.32) among women exposed to 62–84 and 85–94 dB, respectively, whereas among men, the OR in these categories was below 1.00, indicating no effect. In another study there was no elevated risk among men, compared to an OR = 4.01 (95% CI: 0.84-19.11) among women. Conversely, a third study reported a statistically significantly higher OR for CHD only among men (currently exposed vs never exposed), and not for women.

3.2.14 Shiftwork

One review of adverse mental health associated with shiftwork was found (Chung et al, 2009); 7 reviews on reproductive disorders (Yaw et al, 2021; Cai et al, 2019; Chau et al, 2014; Stocker et al, 2014; van Melick et al, 2014; Bonde et al, 2013; Mahoney, 2010) and four reviews on other health effects (Gao et al, 2020; Khan et al, 2020; Leger et al, 2018; Schechter et al, 2008), one of which was excluded as it was not in English (Leger et al, 2018).

Chung et al, 2009 carried out a review of the differential negative impact of shift work on sleep and other health issues in women, comprising 172 papers. The review found that women seem to experience greater sleep difficulty with adjusting to shiftwork than do their male counterparts and that several studies have linked poor sleep among female shiftworkers with physical and mental morbidity, such as muscle aches, respiratory problems, gastrointestinal disorders, fatigue, low mood, breast cancer, and cardiovascular disorders. The paper also investigated reproductive effects of shiftwork, noting that several studies suggest that shiftwork can cause painful or heavier menses and can have a negative impact on pregnant women.

As there were 8 reviews on the impacts of shiftwork on women's reproductive health, we focus here on the 5 most recent publications. Yaw et al reported that shiftwork affected an extensive range of reproductive effects in women, including altered menstrual cycle length, irregular menstrual cycle and increased risk of endometriosis associated with all shift types; shortened menstrual cycle, reduced fecundability and increased risk of early miscarriage associated with night shift; and increased risk of late miscarriage, increased time to pregnancy and increased risk of preterm birth associated with rotating and night shifts.

Cai et al's (2019) systematic review of 62 studies of shiftwork and working hours during pregnancy concluded that pregnant women who work rotating shifts, fixed night shifts, or longer hours have an increased risk of adverse pregnancy outcomes. These included associations of rotating shifts with pre-eclampsia (OR 1.75; 95% CI: 1.01-3.01) and gestational hypertension (OR 1.19; 95% CI: 1.10-1.29), compared to those who worked a fixed day shift. Working fixed night shifts was associated with an increased odds of miscarriage (OR 1.23; 95% CI: 1.03-1.47). Compared with standard hours, working longer hours was associated with an increased odds of miscarriage (OR 1.38; 95% CI: 1.08-1.77). Chau et al, 2014 considered 20 papers in a systematic review to synthesize evidence on the effects of night work on the major

stages of women's reproductive health, specifically the menstrual cycle, fertility, pregnancy, and menopause. They concluded that there were several issues with such studies, including very approximate measurements of night-work exposure and the lack of clear indications of the pattern and characteristics of shift schedules, which contributed to inconsistent findings among studies and made comparisons difficult. They also noted that the impact of night work may differ between occupations.

Stocker et al 2014 carried out a review of the association between shiftwork and early reproductive outcomes (menstrual disruption, subfertility or miscarriage). Results based on 16 cohorts showed shiftworkers had increased rates of menstrual disruption (OR 1.22; 95% CI: 1.15-1.29) and subfertility (OR 1.80; 95% CI: 1.01-3.19) but not miscarriage (OR 0.95; 95% CI: 0.86-1.05). Night shifts were associated with increased miscarriage rates (OR 1.29; 95% CI: 1.11-1.50). Confounders-adjustment led to persistent relationships between shiftwork and menstrual dysfunction (OR 1.15; 95% CI: 1.01-1.31) but not subfertility (OR 1.11; 95% CI: 0.86-1.44). The association between night shifts and miscarriage remained after adjustment for confounders (OR 1.41; 95% CI: 1.22-1.63). van Melick et al 2014 reviewed the pre-existing evidence on the effect of shiftwork or long working hours on the risk of pre-term birth. Based on 16 studies they found no clear or statistically significant relationship between shiftwork and pre-term birth. For long working hours during pregnancy, the summary estimate OR was 1.25 (95% CI: 1.01–1.54) showing a slightly elevated risk.

Other health effects reviewed in relation to shiftwork included type 2 diabetes, cardiovascular disease, obesity and gastrointestinal disease. Gao et al, 2020 reviewed the association between shiftwork and diabetes from 21 studies and reported that the result of meta-analysis indicated that shiftwork was associated with an increased risk of type 2 diabetes (RR 1.10; 95% CI: 1.05–1.14). Subgroup analyses demonstrated that female shiftworkers have increased risk of type 2 diabetes (RR 1.13; 95% CI: 1.07, 1.19) compared to males (RR 1.06; 95% CI: 0.97, 1.17). Khan et al, 2020 evaluated the role of shiftwork and different sleep disorders in causing circadian misalignment and its effect on the risk of cardiovascular diseases. Based on 8 papers, shiftwork and sleep-related disorders were found to cause circadian misalignment, and it was found to be associated with an increase in the risk of cardiovascular diseases. However, there was no examination of gender differences within this review. The full text for Schechter et al 2008 could not be sourced. Information from the abstract showed that the focus of the review was on circadian rhythm and it concluded that shiftworking women have several gender-specific health concerns and may be especially at risk for developing menstrual cycle irregularities, problems with reproductive health, and breast cancer, results which are consistent with the findings of the reviews on reproductive health described above.

4 Synthesis and Discussion

The comprehensive searches that were carried out identified a large volume of literature, even when restricted to review papers rather than primary studies, and following screening by title and abstract, 306 papers were included for more detailed review. A further 179 papers were excluded following this more detailed review and 8 potentially relevant papers could not be sourced. Adverse mental health outcomes were most commonly investigated and almost 40% of identified reviews related to healthcare workers. Despite the substantial number of papers reviewed, evidence around women's occupational health is generally limited and the reviews generally do not report results by gender. The reviews often report weak evidence and/or inconsistent findings and ORs and RRs were invariably <2.0. Relatively few studies specifically address gender differences. Many of the reviews which are included in this umbrella review highlight the difficulties in interpreting results pertaining to women's occupational health due to confounding with gender differences in health outcomes in the general population (e.g. women are around 3 times more likely than men to report common mental health problems[6], while suicide rates are much higher in men (17.4 per 100,000 in England) than women (5.7 per 100,000 in England)[7]). This could be mediated by selection of appropriate female comparator groups in analyses of working women. In addition, attributing differences in health outcomes in men and women to occupation is confounded with the impacts of non-work circumstances on women's health including household and caring responsibilities. Nonetheless, it is possible to identify some trends and patterns from the literature reviewed.

Mental health

There was suggestive evidence, across a range of occupations, that levels of work-related adverse mental health outcomes are both higher in working women than in the general population of women, and higher than in men in the same occupations. Suicide rates in female veterinarians, physicians and nurses tended to be increased compared to their male colleagues, which is notable particularly as overall in the general public suicide rates are higher in men. There is also some evidence of higher rates of secondary PTSD in female healthcare workers and higher levels of anxiety and stress in female scientists compared to males.

Musculoskeletal disorders

MSDs are more common than in the general population in hairdressers, healthcare workers, office workers and, less consistently, teachers. However, there is only weak evidence that occurrence is higher in women than men in these occupations. There was some indication of higher levels of MSDs in female hairdressers, based on one review, but the majority of those included in the studies were female. Among nurses and physical therapists, occurrence of lower back pain tends to be more prevalent in women than men, with some evidence of higher levels of foot and ankle pain in female nurses. Among office workers, there is suggestive evidence of a higher prevalence of neck pain in females.

MSDs in some healthcare workers, specifically surgeons and endoscopists, are linked to ergonomic issues whereby the surgical instruments and endoscopy equipment are not designed for smaller female hands.

Reproductive health

Within this umbrella review, we have focused on reproductive health outcomes which directly affect working women, rather than impacts on the child (e.g. birth defects). A wide range of biological, chemical and physical factors in the workplace have been hypothesised to impact on reproductive health, and it is not always feasible to determine which factor in particular (if any) has contributed to an adverse outcome.

There is weak evidence of adverse effects on time to pregnancy and premature birth in hairdressers, which could be due to exposure to chemicals (e.g. hair dyes) or long periods of time standing during working hours. Similarly, there is an increased risk of spontaneous abortion among healthcare workers in operating theatres which could be due to

[6] https://www.mentalhealth.org.uk/explore-mental-health/statistics/men-women-statistics#:~:text=Today%2C%20women%20are%20three%20times,experience%20common%20mental%20health%20problems.

[7] https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2023

exposure to chemicals such as anaesthetic gases and ionising radiation and/or to prolonged working hours. Long hours of work, prolonged standing and shiftwork (particularly night shifts) have been associated with reproductive effects including miscarriage, gestational hypertension and pre-eclampsia across a number of different occupations. Lifting of heavy loads in pregnancy is also associated with spontaneous abortions.

Violence/assault/sexual harassment

There is consistent evidence that women workers are considerably more likely than men to experience non-physical assault (e.g. bullying, verbal assault) and sexual harassment within the workplace across a wide range of occupations including healthcare, and male dominated occupations such as construction, seafaring and the oil and gas industries. While assault is not itself a health outcome, experience of such behaviour in the workplace is associated with adverse mental health, including PTSD, anxiety and depression. While more women than men suffer from assault and harassment, we found no reports of gender differences in the frequency or type of subsequent health effects.

Other health outcomes

Three reviews investigated urinary incontinence (UI) and lower urinary tract symptoms (LUTS) and found evidence of high prevalence of UI among female athletes, particularly those in high impact sports who had higher prevalence of stress UI. LUTS were associated with strenuous physical demands, prolonged sitting and limited use of toilets at work. Another review reported higher levels of LUTS in women in manual work and noted that those affected tended to modify their behaviours by decreasing voiding, and fluid intake. There was some evidence that sedentary work was also associated with acute myocardial infarction in women workers, and an increase in metabolic syndrome which was greater in women than in men.

Hairdressers, cosmetologists and nurses had a tendency to experience skin disorders including hand eczema and allergic contact dermatitis. This is potentially due to exposure to chemicals and to frequent hand-washing and detergent exposure. There was some evidence that female teachers were more likely to suffer from voice disorders than male teachers.

5 References

References are included in the accompanying spreadsheet.

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