



**European Working Time Directive and doctors' health. A
Systematic review of the available epidemiological
evidence.**

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2014-004916
Article Type:	Research
Date Submitted by the Author:	24-Jan-2014
Complete List of Authors:	Rodriguez-Jareno, Maria-Cruz; Universitat de Girona, 2. Department of Medical Sciences Demou, Evangelia; University of Glasgow, Institute of Health and Wellbeing Vargas, Sergio; Universitat Pompeu Fabra, Centre for Research in Occupational Health Sanati, Kaveh; University of Glasgow, Institute of Health and Wellbeing Skerjanc, Alenka; University Medical Centre, 6. Clinical Institute of Occupational, Traffic and Sports Medicine Reis, Pedro; 7. College of Occupational Medicine, Portuguese Medical Association Helimaki-Aro, Ritva; 8. Helsinki City Occupational Health Centre, Macdonald, Ewan; University of Glasgow, Institute of Health and Wellbeing Serra, Consol; Universitat Pompeu Fabra, Centre for Research in Occupational Health
Primary Subject Heading:	Health policy
Secondary Subject Heading:	Medical management, Research methods, Health services research, Health policy, Evidence based practice
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

1
2
3 **European Working Time Directive and doctors' health. A Systematic review of the**
4 **available epidemiological evidence.**
5
6

7 **Running title:** Long working hours and doctors' health
8
9

10
11
12 ***Corresponding author**
13

14 Dr. Evangelia Demou
15 Healthy Working Lives Group
16 Institute of Health and Wellbeing
17 University of Glasgow
18 Glasgow, G12 8RZ
19 Tel: +44 141 330 3559
20 E-mail: evangelia.demou@glasgow.ac.uk
21
22

23 Maria Cruz Rodriguez-Jareño^{1,2}, Evangelia Demou^{3,*}, Sergio Vargas-Prada⁴, Kaveh A
24 Sanati^{3,5}, Alenka Škerjanc⁶, Pedro G. Reis⁷, Ritva Helimäki-Aro⁸, Ewan B.
25 Macdonald³, Consol Serra^{1,4,9,10}, on behalf of the UEMS Section of Occupational
26 Medicine¹¹.
27
28
29
30
31

- 32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
1. Catalan and Spanish Societies of Occupational Medicine, Barcelona, Spain.
 2. Department of Medical Sciences. School of Medicine. Universitat de Girona. Girona. Spain
 3. Institute of Health and Wellbeing, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, United Kingdom
 4. CiSAL - Centre for Research in Occupational Health, Universitat Pompeu Fabra, Barcelona, Spain.
 5. Occupational Health Department, Epsom & St Helier University Hospitals NHS Trust, Surrey, United Kingdom
 6. Clinical Institute of Occupational, Traffic and Sports Medicine, University Medical Centre, Ljubljana, Slovenia.
 7. College of Occupational Medicine, Portuguese Medical Association, Lisbon, Portugal.
 8. Helsinki City Occupational Health Centre, Helsinki, Finland.
 9. Occupational Health Service, Parc de Salut MAR, Barcelona, Spain.
 10. CIBER of Epidemiology and Public Health. Spain.
 11. UEMS Section of Occupational Medicine. <http://www.uems-occupationalmedicine.org>

55 Word Count: 4,667
56
57
58
59
60

ABSTRACT

Objective: To summarise the available scientific evidence on the health effects of exposure to working beyond the limit number of hours established by the European Working Time Directive (EWTD) on physicians.

Design: A systematic literature search was conducted in PubMed and Embase. Study selection, quality appraisal and data extraction were carried out by independent pairs of researchers using pre-established criteria.

Setting: Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Participants: The total number of participants was 14,338.

Primary and secondary outcome measures: Health effects classified under the International Classification of Diseases (ICD-10).

Results: Over 3,000 citations and 110 full articles were reviewed. From these, eleven studies of high or intermediate quality carried out in North America, Europe and Japan met the inclusion criteria. Six studies included medical residents, junior doctors or house officers and the five others included medical specialists or consultants, medical, dental and general practitioners and hospital physicians. Evidence of an association was found between percutaneous injuries and road traffic accidents with extended hours/day or very long working weeks (LWH). The evidence was insufficient for mood disorders and general health. No studies on other health outcomes were identified.

Conclusions: LWH could increase the risk of percutaneous injuries and road traffic accidents, and possibly other incidents at work through the same pathway. While associations are clear, the existing evidence does not allow for an established causal or "dose-response" relationship between LWH and incidents at work, or for a threshold number of extended hours above which there is a significantly higher risk and the hours physicians could work and remain safe and healthy. Policy makers should consider safety issues when working on relaxing EWTD for doctors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The first systematic review, to our knowledge, on the effects of Long Working Hours (LWH) on physicians' health and safety.
- A systematic literature search conducted in PubMed and Embase with over 3,000 citations and 110 full articles reviewed.
- Eleven studies of high or intermediate quality carried out in North America, Europe and Japan, involving physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.
- The findings of this review confirmed that long working hours are associated with both an increased risk of needlestick injuries and road traffic accidents. Evidence was assessed as low or insufficient for mood disorders and general health.
- This review uncovered the lack of literature on the effect of long working hours on the general health of doctors, a topic that has important health ramifications not only for physicians but for patients too.

KEY WORDS: Working time, "Physicians"[MeSH], "Morbidity"[MeSH], "Occupational Injuries"[MeSH], Systematic review.

INTRODUCTION

The European Working Time Directive (EWTD),[1] applicable to all occupations across the EU, requires a maximum working week of 48 hours and establishes rest periods.[2, 3] Since it came into force in healthcare in 2009, it has been associated with concerns about the provision of health services including continuity of care, lower staffing levels, introduction of shift working, a reduction in training time and the adequate supervision of junior doctors.[4, 5] The large inter-country variations in physicians working hours as well as the mandatory controls over work hours across occupations raises further questions as to the basis of selecting and setting these limits and restrictions.[6] There is evidence of variable compliance to the EWTD within health care across Europe.[4, 5] The medical profession is also increasingly feminised with potential implications for women of childbearing age, which may coincide with the time in the profession where long working hours (LWH) are more likely to happen (i.e. during residency). Constraint on public-sector finances and increasing health care demands, have stimulated the debate on physicians' working hours,[7] with some evidence showing that the quality of health care is positively correlated with the number of physicians available to deliver that care.[8]

The Union of European Medical Specialists (UEMS) was created in 1958 to represent medical specialists in the EU, promote a high standard of training and practice at European level and facilitate the free movement of physicians across European countries.[9] The Occupational Medicine section was created in 1997 and is involved in issues related to specialist training, professional practice and research;[10] elaborating and publishing reference documents,[11] conducting and contributing to surveys,[12-14] and working in partnership with other key European groups.

The trigger for this project was a request by the Council of the UEMS to its Occupational Medicine Section for a position statement on the EWTD and possible health consequences to physicians of a potential removal of this professional group from the current EWTD 48 hours per week limit. An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.

LWH have been associated with several adverse effects on workers' health, such as hypertension, cardiovascular disease, stress, depression, musculoskeletal disorders, chronic infections, diabetes, general health complaints and all-cause mortality in a variety of occupational groups.[15-23] In physicians, there is some evidence suggesting

1
2
3 that LWH can result in impacts such as stress, depression, burnout, injuries, fatigue and
4 sleep deprivation,[24-26] and overwork has been considered one of the most stressful
5 features of physicians' work.[24] Some evidence exists of the beneficial effect of
6 reducing the number of working hours on the quality of life of medical residents [27]
7 and on burnout.[24]
8
9

10
11 However, the relationship between work and health is complex. There is a substantial
12 body of evidence showing that worklessness is associated with poorer health, whereas
13 work is generally good for health and well-being,[28, 29] provided that the work
14 environment is reasonably acceptable and supportive.[30]
15
16
17

18
19 Occupational and non-occupational exposures may play an important role such as the
20 pattern and distribution of working hours, breaks, and recovery periods. Also,
21 psychosocial and organisational factors, such as workload, job control, managers and
22 peer support, training opportunities, individual characteristics and attitudes may be
23 important.[6, 31]
24
25
26

27
28 Finally, physicians are a highly qualified, devoted and motivated professional group.
29 Despite other existing reviews of a more general occupational approach, a review
30 focused on physicians is warranted.
31
32

33
34 The aim of this project was to systematically review whether long-working hours
35 (LWH) -i.e. defined as more than the 48 hour per week limit imposed by the EWTD-
36 are associated with health effects –i.e. classified under the International Classification of
37 Diseases (ICD-10) [32]- in physicians, and to examine what these associations are. This
38 review does not include the potential impact of LWH on patient care or physician
39 training.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

METHODS

The systematic review sought to respond to the following research question: are LWH associated with health effects in physicians? For the purpose of this review, exposure to LWH was defined as working for more than 48 hours per week.[1] Health outcomes included any disease as defined in the ICD-10 [32] and work related injuries. If self-assessed tools on health status were used, only those validated were considered. Burnout, stress and outcomes such as individual symptoms, signs or biological markers (blood pressure, ECG, etc.) were not considered. Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Study identification

Electronic searches were carried out using PubMed and EMBASE as search engines (December 2011). Our search strategy was similar in both databases and consisted of a combination of the following keywords and Mesh terms: night shift, morning shift, evening shift, afternoon shift, shift work, rotating shift, shift combination, shift duration or length, shift system, clockwise rotation, shift roster, extended shifts, night work, evening work, work schedule, work hours, starting time, early start, irregular working hours, direction of rotation, overwork, extended hours, shift rota, workload, work schedule tolerance, sleep deprivation, sleep disorders, chronobiology disorders, circadian rhythm, psychomotor performance, circadian disruption, vigilance, alertness, wakefulness, drowsiness, fatigue, insomnia, hypersomnolence, dyssomnia, eveningness, morningness, neurocognitive performance, concentration difficulties, arousal, health, morbidity, mortality, disease, illness, stress, strain, distress, accident, injur*, death, suicid*, education, medical, physician, medical staff, hospital, doctor, surgeon, house officers, medical school, surgery, surgical.

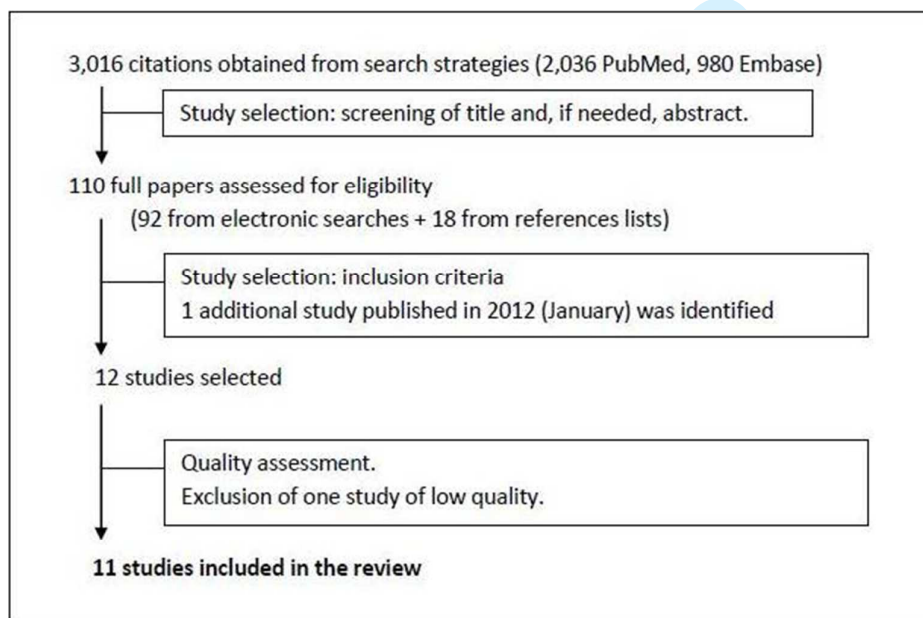
In addition, the references lists of articles selected for inclusion were carefully reviewed to identify additional studies.

Study selection

Studies were included if they measured the association between the exposure to LWH and health effects in physicians, used an observational epidemiological (i.e. cohort, case-control, cross-sectional) or experimental design, and were published in English, French, German, Italian, Slovenian or Spanish. Articles relating to on-call, night or shift work, but with unknown exposure or exposed to less than 48 working hours per week were excluded. They were also excluded if the working groups were other than physicians or addressed only other exposures or outcomes (i.e. patient safety, fatigue, sleep deprivation, social or family disruption).

A total of 2,036 citations were obtained from PubMed and 980 non-duplicated citations using Embase, yielding a total of 3,016 citations that were all screened by independent pairs of reviewers. All titles and, where necessary, abstracts were reviewed. Ninety two potentially suitable publications were identified from the electronic searches, and 18 further studies were identified from the references lists, yielding a total of 110 studies for all of which the full text was obtained and reviewed by independent pairs of reviewers. Disagreements within pairs were resolved by discussion and, where necessary, by a third reviewer who made the final decision. All authors participated as reviewers for screening the citations and full papers using well defined and pre-established criteria. Ninety nine articles were excluded at this stage. One further study was identified that was published after the search period. Finally, 12 papers were considered for quality assessment (Figure 1).

Figure 1. Results of the search strategy, using search engines on PubMed and EMBASE (December 2011) and screening of references lists of identified full papers, study selection and quality assessment.



1
2
3 The methodological quality of the 12 studies was assessed by independent pairs of
4 reviewers. A standardized 16 point scale based on CONSORT and STROBE statements
5 and adapted from a previous systematic review [33] was used. It includes 16 items
6 grouped into 6 areas: 1) objectives, 2) study design, 3) target population and sample, 4)
7 variables, 5) data sources, collection and measurement, and 6) statistical methods. Each
8 item was rated as 1 (the requirement was met), 0.5 (the requirement was partially met)
9 or 0 (the requirement was not or unclearly met). Disagreements within pairs of
10 reviewers were resolved by consensus or, where necessary, by a third reviewer. For
11 each of the 12 studies, a final score based on the sum of all items was assigned and the
12 percentage was calculated based on a maximum score of 16. Study quality was rated as
13 low, moderate or high if it scored less than 60%, between 60% and 79.9%, and 80% or
14 more of the maximum score, respectively.

15
16 One article of low quality was excluded [34] and a total of 11 studies of intermediate or
17 high methodological quality were included for the purpose of this review (figure 1).

28 29 **Data extraction**

30
31 Selected information was extracted from each paper, including publication year, country
32 of origin, study design, setting, study population, sample size, response rate, measure of
33 working hours, definition used for LWH, health outcomes and their measurement, and
34 main results on point risk estimates or frequencies of health outcomes, and their
35 corresponding 95% confidence interval (95%CI), and whether the analyses were
36 adjusted for potential confounders.

41 42 43 **Evidence synthesis**

44
45 To summarise the results on the relationship between LWH and health effects, levels of
46 evidence synthesis was performed. This was based on the methodological quality, study
47 design and the consistency of the study outcomes. The following criteria were based on
48 two previous relevant systematic reviews.[35, 36]

49
50 Strong evidence: consistent results in more than two studies of high quality.

51
52 Moderate evidence: consistent results in one high quality study and one intermediate, or
53 between some studies of intermediate quality.

1
2
3 Insufficient evidence: identification of only one study or inconsistent results across
4 studies;

5
6 Evidence of no association: consistent results of a non-association in two or more
7 studies.
8

9
10 A measure of the possible magnitude of the association was attempted using the
11 following criteria based on the association point estimate (RR = relative risk, rate ratio
12 or odds ratio) when available or otherwise the comparison between two frequencies was
13 used:
14

- 15 • high: $RR > 3.00$
 - 16 • intermediate: $RR = 1.50-3.00$
 - 17 • low: $RR = 1.01-1.49$
 - 18 • no association: $RR=1.00$
 - 19 • unclear
- 20
21
22
23
24
25
26

27 RESULTS

28 We identified 11 studies related to LWH and health effects in physicians that were
29 eligible for inclusion. The outcome of the methodological quality assessment is given in
30 table 1.
31
32

33
34 Methodological quality was appraised as high for 3 of the 11 studies, with scores
35 ranging from 84 to 94%. The other 8 studies were considered as intermediate quality as
36 their scores ranged from 63 to 78%. The majority of all included studies received
37 positive scores on items describing the study objectives, design and the study
38 population (items from areas 1, 2 and 3), as well as the description of exposure and
39 outcome variables (item 4). However, although data sources and collection were well
40 described, reliability and validity of exposure to LWH and health outcome measures
41 had low scores (items 5b and 5c). The statistical methods were in general appropriate,
42 however the confounding variables were not measured in several studies and, as can be
43 seen, the studies did not describe how they addressed missing data (items 6a and 6b).
44
45
46
47
48
49
50
51
52

53 Study characteristics:

54
55 The characteristics of the included studies are described in table 2.
56
57
58
59
60

Table 1. Methodological quality appraisal of the included studies

Study ID		Ayas 2006 [37]	Barger 2005 [38]	Firth- Cozens 1987 [39]	Fisman 2007 [40]	Hayasaka 2007 [41]	Kirkcaldy 1997 [42]	Rosta 2011 [43]	Stamp 2005 [44]	Sundquist 2000 [45]	Varma 2012 [46]	Zahrai 2011 [47]
1	Objectives	Are the objectives or hypotheses of the research described in the paper?	1	1	1	1	1	1	1	1	1	1
2	Study design	Is the study design presented?	1	1	1	1	1	1	1	1	1	1
3a	Target population	Do the authors describe the target population they wanted to research?	1	1	1	1	1	1	1	1	1	1
3b	Sample	Was a random sample of the target population taken? AND was the response rate 60% or more?	0.5	0.5	1	0.5	0.5	0.5	1	1	1	0.5
3c	Sample	Is participant selection described?	1	1	1	1	0.5	1	0	1	1	1
3d	Sample	Is participant recruitment described, or referred to?	1	1	1	1	1	1	1	1	1	0
3e	Sample	Are the inclusion and/or exclusion criteria stated?	1	1	1	1	0.5	0.5	1	1	1	0.5
3f	Sample	Is the study sample described? (minimum description: sample size, gender, age and occupation)	1	1	0	1	1	1	0	0	0	1
3g	Sample	Is the number of participants at each stage of the study reported?	1	1	1	0.5	1	0.5	1	1	1	1
4	Variables	Are the measures of long working hours and the health outcome described?	1	1	0.5	1	1	1	1	1	1	1
5a	Data sources, collection	Do authors describe the source of their data (e.g., official registry, health survey) AND how the data were collected?	1	1	1	1	1	1	1	1	1	1
5b	Measurement	Was reliability of the measure(s) of long working hours mentioned or referred to?	0	0	0	1	0	0	0	1	0	0
5c	Measurement	Was the validity of the measure(s) of long working hours mentioned or referred to?	1	1	0	0	0	0	0	0	0	0
5d	Measurement	Were health outcomes assessed by objective measures or validated self-reporting instruments?	0	1	1	1	1	0	1	1	1	1

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

6a	Statistical methods	Were appropriate statistical methods used and described, including those for addressing confounders?	0.5	1	0.5	1	0.5	0.5	1	0.5	1	1	0.5
6b	Statistical methods	Were the numbers/% of participants with missing data for long working hours and the health outcome indicated AND If more than 20% of data in the primary analyses were missing, were methods used to address missing data?	0	0	0	0.5	0	0	0	0	0	1	0.5
Total score** (%)			12.0 (75)	13.5 (84)	11.0 (69)	13.5 (84)	11.0 (69)	10.0 (63)	10.5 (66)	12.5 (78)	12.0 (75)	15.0 (94)	11.0 (69)
Quality rate***			interm	high	interm	high	interm	interm	interm	interm	interm	high	interm

** Maximum score = 16; *** Quality rate (%): low=<60; intermediate (interm)=60-79; high=80-100.

Peer review only

Table 2. Characteristics of the included studies.

Study ID	Country	Design*	Setting	Participants and sample size (response rate)	Working hours	Health outcomes	Quality score (%)
Ayas 2006 [37]	United States	Cross-over	Hospital	Interns in postgraduate residency programs Sample size: 2,737 (80%)	Mean (SD) hrs 75.3:self-reported, monthly survey. Strong correlation (Pearson $r=0.76$; p 0.001) with hours worked (69.3) from work diaries of randomly selected subset of interns. Extended periods (>20 hrs/day) vs. non extended periods (first 12 hrs at work).	Self-reported percutaneous injuries	12.0 (75)
Barger 2005 [38]	United States	Cohort, prospective (1 year)	Hospital	Residents first postgraduate year (interns). Sample size: 2,554 (75%)	Average 70.7±26.0 hrs/week. Extended shift (\geq 24hrs) vs. non extended shift (<24 hours). Self-reported, validated.	Self-reported and documented motor vehicle crashes.	13.5 (84)
Firth Cozens 1987 [39]	United Kingdom	Cohort, prospective (1 year)	Hospital	Junior house officers Sample size: 170 (72%)	Mean number of hours per week = 90.6 hours (include on call). Self-reported.	GHQ-12 (case: score \geq 2) and SCLDS, self-reported	11.0 (69)
Fisman 2007 [40]	United States	Cross-over	Hospital	Medical trainees vs. other HCW. Sample size: 109 vs. 241 (46%)	Median number of hours per week: medical trainees = 70; other HCW = 40 ($p<0.001$). Self-reported, high reliability.	Reported percutaneous injuries to employee health care service.	13.5 (84)
Hayasaka 2007 [41]	Japan	Cross-sectional	Hospital, clinics, other	Female physicians Sample size: 367 (63%)	Comparison of increasing number of hrs/week from \leq 30 to >50, self-reported.	GHQ-30 (case: score \geq 8), self-reported	11.0 (69)
Kirkcaldy 1997[42]	Germany	Cross-sectional	Not specified	Medical and dental practitioners. Sample size: 2,500 (not specified)	Long hours: mean 58.36 hrs/week Short hours: mean 38.17 hrs/week Self-reported.	Self-reported traffic accidents	10.0 (63)
Rosta 2011[43]	Germany	Cross-sectional	Hospital	Hospital physicians Sample size: 1,260 Germans and 562 Norwegians (58% and 65%,)	German vs. Norwegian physicians (%): Hours per day >9 = 58.8 vs. 26.7 60 hours on-call per month = 63.4 vs. 18.3 Self-reported.	Validated questionnaire on self-rated health	10.5 (66)
Stamp 2005 [44]	United States	Before-and-after	Hospital	Residents of general surgery Sample size: 28 (97%)	Changes of work patterns, after reduction from 90-110 to 78-80 work hrs/week.	SF-36, mental health; BDI, depression; self-reported	12.5 (78)
Sundquist 2000 [45]	Sweden	Cross-sectional	Primary care	General practitioners Sample size: 1,004 (72%)	Overtime defined as working at least 47 hrs/week. Self-reported.	Swedish SF-36, impaired mental health, self-reported	12.0 (75)
Varma 2012 [46]	Denmark	Cohort, prospective (20 months)	Hospital	Senior medical consultants Sample size: 2,790 (62%)	Long work hours (>40hrs/week). Self-reported.	Depression: redemption of anti-depressive drug prescriptions	15.0 (94)
Zahrai 2011 [47]	Canada	Cohort, prospective (6 months)	Hospital	Orthopaedic surgery residents Sample size: 16 (not specified)	Night float (n=9): 77.8% did >80h/week at baseline; 71.4% at follow-up). Standard call (n=7): 57.1% did >80h week at baseline; 80% at follow-up.	SF-36, mental health score, self-reported	11.0 (69)

* Follow-up period in brackets for prospective cohort studies; GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Five had been carried out in North America (4 in the United States [37, 38, 40, 44] and 1 in Canada [47]), five in European countries (Denmark,[46] Germany,[42] Sweden,[45] and the United Kingdom [39]) and one study in Japan.[41] Four used a prospective cohort design (follow-up ranging from 6 to 20 months), 2 were case-crossover, 4 cross-sectional, and 1 was a before and after study. Overall, the total number of participants was 14,338 and included medical residents, junior doctors or house officers only working in hospitals, medical specialists or consultants, medical and dental practitioners, general practitioners, hospital physicians and one study included female physicians from a community service. Most studies (n=9) compared different working hour patterns within the same group of physicians, one compared physicians from two different countries,[43] and one included other health care workers as the comparison group.[40]

LWH was defined as more than 48hours/week in most studies, and some did not provide a definition. Two studies considered LWH below 48/week.[43, 45] All the included studies investigated health effects associated with working more than 48h/week, with number of hours ranging between <30 to 110hours/week. One paper studied the effects of an increasing number of hours from 30 to more than 50h/week.[41] Others studied more than 40h/week,[46] 47h/week,[45] above 58h/week [43](two studies) and 6 studies referred to more than 70h/week,[37-40, 44, 47] one of which compared 78-80h/week to 90-110 weekly hours.[44] Information on working hours was self-reported in nine studies, with reasonably good validity only in two studies [37, 38] and reliability in one.[40] In the other two studies it was obtained from established work schedules.[44, 47]

Identified health outcomes that fulfilled the inclusion criteria were percutaneous injuries, motor vehicle accidents, mood disorders and general health. Information was self-reported in all studies using well known validated questionnaires, except three studies that used documented information on motor vehicle crashes,[37] reported percutaneous injuries [39] and antidepressant prescription data as a surrogate of depression.[46]

Summary of findings:

Table 3 shows the findings from each of the 11 studies.

Table 3. Results on the association between long working hours and identified health effects in physicians.

Health outcome	Main results	Adjustment by confounders	Study ID
Percutaneous injuries	Odds ratio (95% CI) for injuries during extended (>20 hours/day) vs. non extended periods (first 12 hours at work): All percutaneous injuries: 1.61 (1.46-1.78); Injuries reported to OH: 1.83 (1.48-2.28); Injuries in the ICU: 1.87 (0.69-5.04); Injuries in the operating room or labour and delivery: 1.77 (1.49-2.09); Injuries in the ICU, non-ICU, or ED: 2.17 (1.56-3.00)	Not adjusted	Ayas 2006[37]
Percutaneous injuries	Medical trainees vs. other health care workers: total median working hours: 70 vs. 40 hours (p<.001); median previous working hours at the time of injury: 6.5 vs. 5 hours (p<.001). Odds ratio (95% CI) for self-reported fatigue:> 40h in the past week: 3.5 (2.06-5.92); during more than 5d in past week: 4.2 (4.46-7.15); >12h at work before injury: 8.58 (3.7-19.86). Incidence rate ratio (95%CI) for injuries and fatigue: all workers: 1.40 (1.03-1.90); medical trainees: 2.94 (1.71-5.07); other HCWs: 0.66-1.42) (p 001 for heterogeneity).	Age and sex	Fisman 2007[40]
Motor vehicle accidents	Relative risk (95% CI), after extended shift (≥ 24hrs) vs. non extended shift (<24 hours): Crashes = 2.3 (1.6-3.3); Near miss accidents = 5.9 (5.4–6.3)	Age and sex	Barger 2005[38]
Motor vehicle accidents	Incidence rates of driving accidents on house visits: Long hours (mean 58.36 hrs/week) = 0.10 (0.31) vs. short hours (mean 38.17 hrs/week) = 0.02 (0.18) vs. p<0.05	Not adjusted	Kirkcaldy 1997[42]
Mood disorders, depression	Hazard ratio (95% CI) hours/week intervals and redemption of anti-depressive drug prescription(reference group: 37-40 h/week): 25–36 h: 0.83 (0.24–2.82); 41–44 h: 0.95 (0.50–1.77); 45–49 h: 0.88 (0.43–1.78); 50–54 h: 0.83 (0.32–2.14); 55–59 h: 0.67 (0.15–2.94); >60 h: 0.48 (0.06–3.68). Cox regression analysis of work hours as a continuous variable: HR=0.93 (0.76–1.13)	Age, sex, marital status, medical specialty, decision authority at work, social support at work, quantitative work demands and previous redemption of AD drug prescription	Varma 2012[46]
Mood disorders, GHQ-30	Prevalence of cases by working time (hours/week) ≤ 30 hours: 35.7% (41/115); >30 to 40 hours: 39.0% (39/100); >40 to 50 hours: 37.7% (26/69); >50 hours: 56.8% (46/81); p=0.0179 Stepwise multiple logistic regression, >50 h/wk. vs. ≤50 h/wk.: parameter 0.635 (p=0.0293)	Marital status, medical facility, position, and night duty.	Hayasaka 2007[41]
Mood disorders, GHQ-12 and SCLDS	No association was found between number of hours worked in a week and depression.	Not adjusted	Firth Cozens 1987[39]
Mood disorders, SF-36	Scores when night float vs. standard call at baseline and follow-up: Mental health mean score (SD): baseline = 57.33 (22.63) vs. 65.71 (7.61); follow up = 52.00 (15.49) vs. 60.80 (11.45); p=0.72 Mental health component summary (SD), baseline = 34.84 (14.06) vs. 40.21 (7.61) ; follow up = 30.15 (10.71) vs. 42.40 (6.23); p=0.39 Regression analysis: increased number of hours in hospital correlated with significantly lower SF-36 scores in almost all domains.	Not adjusted	Zahrai 2011[47]
Mood disorders, SF-36 and BDI	Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hors/week): Mental health SF-36): no statistically significant improvement Individual questions BDI before and after duty hours limitations, only energy level statistically significant.	Not adjusted	Stamp 2005[44]

Health outcome	Main results	Adjustment by confounders	Study ID
Mood disorders, SF-36	Odds ratio (95% CI) for working 47 hours per week or more: Impaired mental health, men: 1.59 (0.95-2.66); women: 1.86 (1.03-3.37)	Age and amount of time in practice	Sundquist 2000 [45]
General health, SF-36	SF-36: Scores when night float vs. standard call at baseline and follow-up: General health mean score (SD): baseline = 62.11 (17.47) vs. 77.57 (24.25); follow up = 56.43 (24.89) vs. 84.20 (16.50); p=0.41 Physical health component summary (SD): baseline = 46.16 (13.15) vs. 52.01 (13.33); follow up = 39.32 (9.80) vs. 56.15 (2.18); p=0.015 Vitality mean score (SD): baseline = 51.67 (14.58) vs. 51.43 (15.74); follow up = 48.57 (14.92) vs. 51.00 (10.84); p=0.20 Regression analysis demonstrated that the increased number of hours spent in hospital correlated with significantly lower general health, physical function, mental health, role emotional, social function and mental component summary scale scores (all p < 0.05)	Not adjusted	Zahrai 2011 [47]
General health, SF-36	SF-36, BDI: Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week): Physical health: no statistically significant differences.	Not adjusted	Stamp 2005 [44]
General health, SF-36	SF-36: Odds ratio (95% CI) adjusted for age and time in practice, for working 47 hours per week or more: Impaired general health: men = 1.66 (1.00-2.77); women = 1.59 (1.00-3.17)	Age and amount of time in practice	Sundquist 2000 [45]
General health, SF-36	Self-rated health: Odds ratio (95% CI) of good self-rated health (logistic regression): Norwegian work time pattern**= 1.35 (1.03-1.77); working in Norway = 4.17 (3.02 - 5.73).	Age, sex and country of work	Rosta 2011 [43]

**Not working more than 9 hours a day and having more than 60 hours a month on-call); GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3 *Percutaneous injuries:* One study of high quality and one of intermediate quality, with
4 non-adjusted analyses, showed consistent results in medical trainees. Ayas et al. found
5 an increased risk of percutaneous injuries associated with working more than 20
6 hours/day compared to non-extended hour periods, except in intensive care units;[37]
7 Fisman et al. found an association between self-reported fatigue and the number of
8 working hours at the time of injury and a 3-fold increased risk of sharp injuries in
9 medical trainees compared to other health care workers (median of working hours/week
10 before the injury: 70 vs. 40;p<.001).[40]
11

12
13
14
15
16 *Motor vehicle accidents:* Two studies of high and intermediate quality showed that long
17 working weeks were associated with an at least two-fold increased risk. Barger et al.
18 found adjusted increased risks for car crashes (OR 2.3; 95%CI 1.6-3.3) and near miss
19 accidents (OR 5.9; 95%CI 5.4-6.3) associated with working extended shifts.[38]
20 Kirkcaldy et al. showed that non-adjusted incidence rates of traffic accidents on house
21 visits was five times as much when physicians worked for a mean of 58 hours/week
22 compared to 38 hours/week (p<0.05).[42]
23

24
25
26
27
28 *Mood disorders:* Six studies of intermediate and high quality found contradictory
29 results for mood disorders. Three of them, all of intermediate quality, provided evidence
30 of an association between LWH and mental health problems. The prevalence of GHQ-
31 30 cases was higher for female physicians working above 50 hours/week than for those
32 working 30 or less hours/week (p<0.05).[41] and an increased adjusted risk of impaired
33 mental health was found for men and women general practitioners who worked for 47
34 hours per week or more.[45] Zahrai et al. found that increased number of hours spent by
35 residents in hospital correlated significantly with lower mental health and mental
36 component summary scale scores (SF-36).[47] Three other studies, one of which of
37 high quality, did not find an association between depression or mood disorders and
38 LWH. Varma et al. did not find higher adjusted risks of depression associated with
39 increased number of hours in senior medical consultants, even when they worked for
40 more than 60 hours per week.[46] Depression or mood disorders measured with GHQ-
41 12, SCLDS or BDI, all validated tools for mental health, were not associated with
42 increased number of working hours [39] nor improved after decreasing the number of
43 hours from 90-110 to 78-80 hours per week in residents.[44]
44
45
46
47
48
49
50
51
52
53
54

55
56 *General health:* Four studies of intermediate quality analysed the association between
57 LWH and general health. Zahrai et al. found that increased number of hours spent by
58
59
60

residents in hospital correlated significantly with poorer general health, physical function and vitality using SF-36.[47] A comparative study of physicians in two different countries found that Norwegians showed higher non-adjusted prevalence of self-reported good health compared to physicians in Germany who worked longer hours.[43] An increased adjusted risk of impaired general health was found for men and women general practitioners who worked for more than 47 hours per week.[45] However, following the implementation of reducing the number of hours from an average of 90-110hours/week to 78-80hours/week did not lead to an overall improvement of residents self-reported physical health.[44]

Synthesis of the evidence:

The levels of evidence synthesis obtained from the analysis of the 11 studies included in this review are shown in table 4.

Table 4. Available scientific evidence on the health problems associated with long working hours in physicians: levels of evidence synthesis.

Health outcome	Degree of evidence*	Magnitude of the association**	Studies ID
Percutaneous injuries	++	++	Ayas 2006[37], Fisman 2007[40]
Motor vehicle accidents	++	++	Barger 2005[38], Kirkcaldy 1997[42]
Mood disorders	+	+/-	Varma 2012[46], Hayasaka 2007[41], Firth Cozens 2001[39], Zahrai 2011[47], Stamp 2005[44], Sundquist 2000[45]
General health	+	+/-	Zahrai 2011[47], Stamp 2005[44], Sundquist 2000[45], Rosta 2011[43]

* Strong evidence (+++): consistent results in more than 2 studies of high quality; Moderate evidence (++) : consistent results in two studies of high quality, or one high quality study and one intermediate, or between some studies of intermediate quality; Insufficient evidence (+): identification of only one study or inconsistent results across studies; Evidence of no association (-): consistent results of a non-association in two or more studies.

** Magnitude of the association: it refers to the magnitude of the association point estimate (RR = relative risk, rate ratio or odds ratio): high (+++) if RR > 3; intermediate (++) if RR = 1.5-3; low (+) if RR < 1.5; no association (-); unclear (+/-).

1
2
3 There is moderate evidence of an association between LWH and percutaneous and
4 motor vehicle accidents in physicians. This evidence comes from one study of high
5 quality and another of intermediate quality both for percutaneous injuries, and for motor
6 vehicle accidents and the magnitude of this association could be intermediate.
7
8

9
10 For mood disorders and general health there is a low or insufficient level of evidence of
11 an association with LWH in physicians. This comes from 6 studies on mood disorders
12 and 4 on general health of high and intermediate methodological quality and
13 inconsistent results among them. No conclusion can be drawn about the magnitude of
14 such associations if existed.
15
16
17
18
19

20 21 **DISCUSSION**

22
23 This review found moderate scientific evidence for a positive association of
24 intermediate magnitude between exposure to LWH and percutaneous injuries and motor
25 vehicle accidents in physicians. Evidence was assessed as low or insufficient for mood
26 disorders and general health.
27
28
29

30
31 To our knowledge, this is the first systematic review on the effects of LWH on
32 physicians' health and safety. The extensive searches were restricted to indexed
33 journals. We systematically identified, selected and assessed the methodological quality
34 of studies by means of independent pairs of reviewers. The quality assessment form and
35 the levels of evidence used in this review were based on CONSORT and STROBE
36 statements and on previous systematic reviews.[33, 35, 36] To give some estimate of
37 the potential magnitude of the effect, we added levels based on the point estimates of
38 measures of association provided by the studies. However, such levels had not been
39 previously established.
40
41
42
43
44
45
46
47

48 **Strengths and limitations of the studies**

49
50 Four studies had a longitudinal prospective design, however only two of them used a
51 robust methodology. Two other studies used a crossover design, which reduces the
52 likelihood of individual variability and confounding, and were considered well
53 designed. Four studies, all rated as intermediate methodological quality, were cross
54 sectional in design and therefore it is difficult to draw causal relationships from them.
55
56
57
58
59
60

1
2
3 Although reverse causality cannot be ruled out from cross-sectional designs, it is
4 unlikely that poorer health determines longer working hours than their healthier peers.
5 One study used a quasi-experimental design but lacked a control group.
6
7

8 Other limitations include the variability, validity and reliability of working hours, which
9 in most studies was self-reported. Although only those papers specifying the number of
10 working hours were accepted, shift and night work might have worked as confounders
11 too, as it is difficult to acknowledge which proportion of the health effects observed was
12 due exclusively to the LWH component and not due, for instance, to stress, fatigue or
13 sleep deprivation. Moreover, the studies did not discriminate between time spent
14 actively working or asleep while on call, though the EWTD considers all hours on call
15 as working time.
16
17
18
19
20
21

22 Health outcomes were measured mainly based upon self-report, with the exception of
23 documented motor vehicle crashes,[37] reported percutaneous injuries [39] and register-
24 notified anti-depressive drug prescriptions.[45] No studies with other objective
25 measures of health (e.g., mortality) or mental disease (e.g., hospital data) were
26 identified. However, self-reported or perceived health was assessed by validated and
27 widely used instruments, especially when health status (general, mental or physical
28 health) or ill-health symptoms are evaluated. Nonetheless, this raises the possibility that
29 the observed associations might reflect differences in propensity to report health
30 problems when they occur rather than true differences in the risk of worse health status.
31 We cannot rule this out, but the higher propensity for reporting among those who work
32 for longer hours and poorer work schedule patterns would have to relate specifically to
33 the reporting of ill-health rather than non-ill health. It seems unlikely that major
34 differences in propensity to report would extend to a more concrete outcome.
35
36
37
38
39
40
41
42
43

44 The majority of the studies of this review took into account confounding variables in
45 their analyses, such as sex and age. However, none of the studies analysed the potential
46 effect of modifying factors, such as psychosocial aspects at work, including attitudes,
47 motivation, job requirements, demands and content, organisational climate, social
48 relationships at work, work satisfaction, supportive organisation, or the relative number
49 of physicians and other staff available for patient care. Neither were important aspects
50 outside of work, such as life events or lifestyles, taken into account. The study of
51 Japanese female physicians found significant differences by marital status with higher
52 GHQ scores for those who were married.[41] There are significant differences in the
53
54
55
56
57
58
59
60

1
2
3 number of physicians per capita across different countries and this together with the
4 structure and organisation of health services are potential confounders too that were not
5 addressed in the selected studies across countries.
6
7

8
9 A relevant outcome from this review would be to establish a threshold number of
10 extended hours above which there is a significantly higher risk. There is a lack of
11 evidence for a dose-response relationship and nor does the evidence give any indication
12 for a threshold number of hours that physicians could work and remain safe and healthy.
13
14 Finally, the heterogeneity of the included studies did not allow a more quantitative
15 synthesis, and a level of evidence approach was used instead.
16
17
18
19

20 21 22 **Comparison with other studies** 23

24 Our findings of an association between LWH and injuries and accidents in physicians
25 are consistent with research in other occupational groups. Dembe et al. carried out a
26 longitudinal survey in the US including more than 10,000 workers from a variety of
27 occupations and settings.[16] A strong dose-response effect (adjusted for age, gender,
28 occupation, industry and region) was found between LWH and injuries above 40h/week
29 and 8h/day; jobs with overtime schedules were associated with a 61% higher injury
30 hazard rate compared to jobs without overtime; working at least 12 hours per day was
31 associated with a 37% increased hazard rate, and working at least 60 hours per week
32 was associated with a 23% increased hazard rate. They concluded that LWH might
33 indirectly precipitate workplace injuries through a causal process by inducing fatigue or
34 stress in workers. In our review we found that information about the length of shift
35 work varied across studies, some analysing shifts of up to twenty four hours. Work that
36 included such shifts was more strongly associated with accidents and injuries.[37, 38]
37
38

39 We found insufficient evidence of an association between LWH and mood disorders,
40 other diseases and general health in physicians, despite some scientific evidence
41 suggesting that LWH increase morbidity and mortality in other occupations.[16-23]
42
43

44 Possible explanations for these inconsistencies might be the scarcity of high quality
45 research, and the fact that some of the included papers did not fully address the effect of
46 confounding factors, and the possibility that working as a physician might have a
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 protective effect by itself, for instance through higher motivation and social recognition
4 relative to other occupations.
5

6
7 Stamp et al., in the only before and after study, did not find significant differences for
8 mood disorder or general health before and after implementing requirements to reduce
9 working schedules to 80h/week in residents.[44] It is debatable, however, whether any
10 conclusions can be drawn from the impact of reducing extremely high working hours
11 (90-110hours/week) to very high working hours (78-80hours/week).
12
13
14

15
16
17 Although we searched for and identified literature describing associations between
18 LWH and increased mortality in doctors,[48, 49] none of those studies specified the
19 number of hours worked, and therefore were not included.
20
21

22 23 **Recommendations for future research**

24
25 Further research, including well designed prospective and retrospective longitudinal
26 studies, is needed in this field to establish on scientific grounds what number of hours
27 are safe, both to patients and physicians. Also studies on long term health effects should
28 be considered.
29
30
31

32
33 This review was aimed to study exclusively possible detrimental health effects of LWH
34 (more than 48 hours per week) to physicians. Other systematic reviews should be
35 conducted addressing issues, such as the impact of working hours on doctor's well-
36 being and quality of life, the quality of junior doctors training, the quality and continuity
37 of care and impact on patient safety. Also, from a staffing perspective, the economic
38 and social burden of sick leave and physicians leaving the profession are important
39 issues that were beyond the scope of this review and that should be considered in future
40 research. Other established criteria [50] that working hours should be 'family friendly',
41 promote gender equality, enhance productivity or facilitate worker choice and influence
42 over working hours, were not addressed. Further research is needed in these other areas.
43
44
45
46
47
48
49
50

51 52 **Conclusions**

53
54 The findings of this review have confirmed that long working hours are associated with
55 both an increased risk of needlestick injuries and road traffic accidents. The fact that
56 these associations are labelled moderate in this review, should not preclude safety
57
58
59
60

1
2
3 procedures and measures being assessed and reassessed to ensure maximum physician
4 and patient safety. The reduction of needlestick injuries requires improved use of safe
5 sharp devices, compliance with safe working procedures, training and regular audits of
6 working practices, particularly for junior doctors who are at greatest risk of needlestick
7 injuries, possibly due to inadequate training.[51, 52] The risk of road traffic accidents
8 could be reduced by discouraging driving after very long shifts (more than 16 hours)
9 and where there is sleep deprivation.[53] Transport should be provided by the employer
10 in these situations. This is a pragmatic recommendation which recognises that long
11 working hours have not been eliminated as a result of the EWTD.
12
13
14
15
16
17

18 This review uncovered the lack of literature on the effect of long working hours on the
19 general health of doctors, a topic that has important health ramifications not only for
20 physicians but for patients too. However, the paucity of available studies, which does
21 not allow for a causal or dose-response relationship to be established, raises further
22 questions about the evidence-base of the current 48 hour limit, especially as this is not
23 enforced strictly and junior doctors, for example in the UK, may opt-out.[54] It may be
24 relevant that the EWTD was not based entirely on science but also took into account, as
25 does all EU legislation, the views of "social partners".[3]
26
27
28
29
30
31

32 It is likely that the mechanism for these increased health and safety risks is fatigue, and
33 our finding of increased risk of accidents to staff, may also be associated with increased
34 risk of clinical errors. Patient safety was not the purpose of this review but long working
35 hours are well recognised to cause decrement in performance both in health care and
36 other professions, where the performance of staff can be safety critical, such as airline
37 pilots, and professional drivers.[55]
38
39
40
41
42

43 In addition the EWTD has been associated with real concerns about the adequacy of the
44 training of doctors given their reduced exposure to patient care, and the lack of
45 experience of the patient journey, imposed by adherence to the EWTD.[4] This is
46 potentially exacerbated at the same time by the constraints on the overall duration of
47 training imposed by other EU directives.[56] Further reviews of the EWTD, with regard
48 to this unique group of workers, need to take into account other social factors such as
49 the impact on patient care. This is particularly the case when all health care systems are
50 under strain because of burgeoning demands and limited resources.[4]
51
52
53
54
55
56
57
58
59
60

1
2
3 The findings of this systematic review lead to the suggestion of the following guidelines
4 in the event of non-compliance with the EWTD: 1) long shifts should be avoided to
5 protect both physicians' health and patient safety and no shift should be longer than 16
6 hours (and then exceptionally);[25] 2) Physicians should be discouraged from driving
7 after long shifts to reduce the risk of motor accidents;[38, 42] 3) rigorous attention
8 should be paid to reducing the risk of sharps injuries;[37, 40] 4) organisational aspects
9 such as workload and job control, as well as the pattern and distribution of working
10 hours, breaks and recovery periods should be carefully taken into account, in order to
11 avoid fatigue and sleep deprivation that could lead to mistakes and accidents;[57, 58] 5)
12 Physicians should work in supportive psychosocial environments, in teams, and with
13 adequate training and supervision as their wellbeing is important also for the health of
14 their patients.[57, 58]

15
16
17
18
19
20
21
22
23 Further research is required to establish any longer term effects such as on mortality and
24 mental health, also the impact of the nature of the work organisation taking into account
25 the psychosocial aspects of the physicians working and non-working lives, and to
26 determine how many hours are safe for physicians to work.
27
28
29
30
31

32 **ACKNOWLEDGMENTS**

33
34 Leena Isotalo, Trial Search Coordinator at the Cochrane Occupational Safety and
35 Health Review Group, designed and conducted the final search of the evidence using
36 Medline and Embase databases.
37
38
39
40
41

42 **CONFLICT OF INTERESTS**

43
44 None. No financial relationships with any organisations that might have an interest in
45 the submitted work, and no other relationships or activities that could appear to have
46 influenced the submitted work.
47
48
49
50

51 **FUNDING**

52
53 The Section of Occupational Medicine of the UEMS provided limited support to the
54 work of all authors (MCR, ED, SVP, KS, AS, PR, RH), with the exception of the senior
55 authors (EBM, CS). The expenses of one meeting of the core group (MCR, ED, SVP,
56 EBM, CS) were also funded by the Section. **Role of funding source:** The Section of
57
58
59
60

1
2
3 Occupational Medicine of the UEMS acted in its role of promoting and contributing to
4 the research in Occupational Medicine.
5
6
7

8 9 **AUTHORS' CONTRIBUTIONS:**

10 Mari Cruz Rodríguez-Jareño, Evangelia Demou, Sergio Vargas-Prada, Alenka Škerjanc,
11 Kaveh A Sanati, Ewan B. Macdonald and Consol Serra conceived and submitted the
12 design, carried out the acquisition of data, analysis and interpretation of data, drafted the
13 article and revised it.
14
15

16
17 Pedro G. Reis and Ritva Helimäki-Aro contributed to acquisition of data, analysis and
18 interpretation of data, drafted the article and revised it.
19

20
21 All authors gave final approval of the version to be published, and agree to be
22 accountable for all aspects of the work.
23
24
25

26
27 **ETHICS COMMITTEE APPROVAL** was not sought as no patients were involved in
28 this study.
29
30
31

32 33 **REFERENCES**

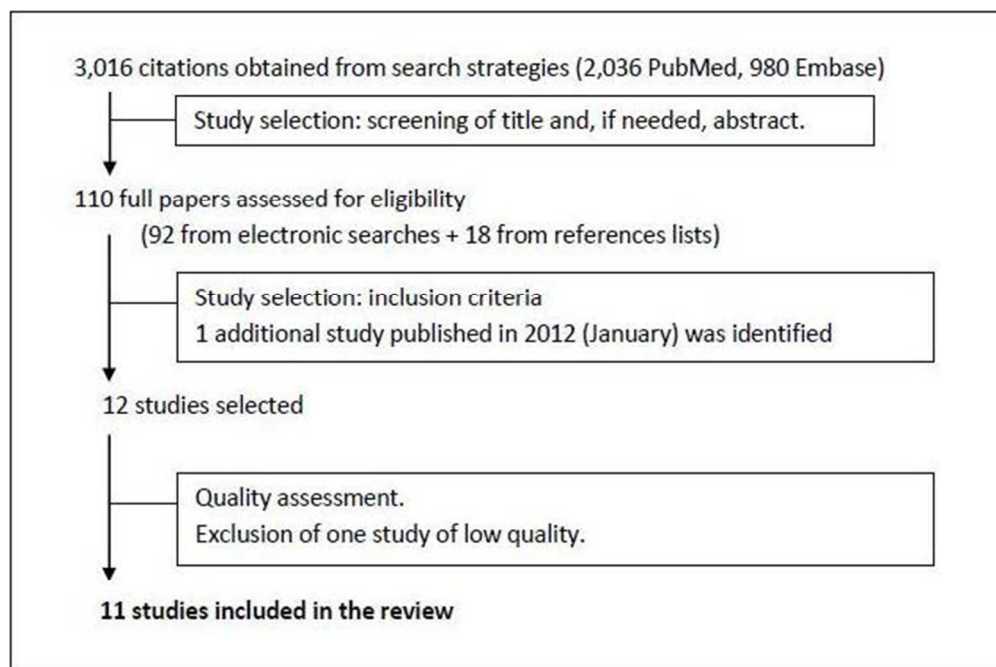
- 34 1 EUR-Lex. Directive 2003/88/EC of the European Parliament and of the Council of 4
35 November 2003 concerning certain aspects of the organisation of working time. In:
36 Union OJotE, ed. Brussels: Official Journal of the European Union, 2003.
37
38 2 EPHA. 2012 EPHA Briefing on the European Working Time Directive (EWTD)
39 http://www.eph.org/IMG/pdf/EPHA_Briefing_EWTD_Oct2012_FINAL.pdf;
40 Access Year 2012.
41
42 3 European Commission. 2013 Working Conditions-Working Time Directive.
43 <http://ec.europa.eu/social/main.jsp?catId=706&langId=en&intPageId=205>; Access
44 Date December 2013.
45
46 4 House J. Calling time on doctors' working hours. *Lancet* 2009;**373**:2011-12.
47
48 5 The Lancet. Doctors' training and the European Working Time Directive. *Lancet*
49 2010;**375**:2121.
50
51 6 Leff D, Aziz O, Darzi A. Trucks, planes, and scalpels - Is there an evidence-based
52 approach to surgeons' working hours? *Arch Surg* 2007;**142**:817-20.
53
54 7 Parthasarathy S. Sleep and the medical profession. *Curr Opin Pulm Med*
55 2005;**11**:507-12.
56
57
58
59
60

- 1
2
3 8 Dr. Foster Hospital Guide. 2011 www.drfoosterhealth.co.uk; Access Date February
4 2011.
5
6 9 UEMS. 2012 The Union of European Medical Specialists. www.uems.net; Access
7 Year 2012.
8
9 10 Macdonald EB, Ritchie KA, Murray KJ, Gilmour WH. Requirements for
10 occupational medicine training in Europe: a Delphi study. *Occup Environ Med*
11 2000;**57**:98-105.
12
13 11 Macdonald E, Baransky B, Wilford J. Occupational Medicine in Europe: Scope and
14 Competencies. In: Health WECfEa, ed. Health, Environment and Safety in Enterprises
15 Series n. 3. Bilthoven, The Netherlands, 2000.
16
17 12 Ballester M, Cordell N, Rodriguez Jareno MC, Serra C, Med USO. A European
18 survey of professional bodies representing occupational medicine specialists. *Occup*
19 *Med (Oxf)* 2012;**62**:366-70.
20
21 22 13 Cashman C, Slovak A. The occupational medicine agenda: Routes and standards of
23 specialization in occupational medicine in Europe. *Occup Med (Oxf)* 2005;**55**:308-11.
24
25 26 14 De Schryver A, Claesen B, Meheus A, van Sprundel M, Francois G. European
27 survey of hepatitis B vaccination policies for healthcare workers. *Eur J Public*
28 *Health* 2011;**21**:338-43.
29
30 31 15 Bannai A, Tamakoshi A. The association between long working hours and health: A
32 systematic review of epidemiological evidence. *Scand J Work Environ Health* 2013.
33
34 35 16 Dembe AE, Erickson JB, Delbos RG, Banks SM. The impact of overtime and long
36 work hours on occupational injuries and illnesses: new evidence from the United
37 States. *Occup Environ Med* 2005;**62**:588-97.
38
39 40 17 Johnson JV, Lipscomb J. Long working hours, occupational health and the changing
41 nature of work organization. *Am J Ind Med* 2006;**49**:921-9.
42
43 44 18 Kivimäki M, Batty GD, Hamer M, et al. Using Additional Information on Working
45 Hours to Predict Coronary Heart Disease. *Ann Intern Med* 2011;**154**.
46
47 48 19 Liu Y, Tanaka H, Fukuoka Heart Study G. Overtime work, insufficient sleep, and
49 risk of non-fatal acute myocardial infarction in Japanese men. *Occup Environ Med*
50 2002;**59**:447-51.
51
52 53 20 Sokejima S, Kagamimori S. Working hours as a risk factor for acute myocardial
54 infarction in Japan: case-control study. *BMJ* 1998;**317**:775-80.
55
56 57 21 Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated with
58 long working hours: A review of the current position. *Occup Environ Med*
59 1997;**54**:367-75.
60
61 22 Virtanen M, Ferrie JE, Singh-Manoux A, et al. Long working hours and symptoms
of anxiety and depression: a 5-year follow-up of the Whitehall II study. *Psychol Med*
2011;**41**:2485-94.

- 1
2
3 23 Virtanen M, Stansfeld SA, Fuhrer R, Ferrie JE, Kivimaki M. Overtime work as a
4 predictor of major depressive episode: a 5-year follow-up of the Whitehall II study.
5 *PloS One* 2012;**7**:e30719.
6
- 7 24 Gopal R, Glasheen JJ, Miyoshi TJ, Prochazka AV. Burnout and internal medicine
8 resident work-hour restrictions. *Arch Intern Med* 2005;**165**:2595-600.
9
- 10 25 Reed DA, Fletcher KE, Arora VM. Systematic Review: Association of Shift Length,
11 Protected Sleep Time, and Night Float With Patient Care, Residents' Health, and
12 Education. *Ann Intern Med* 2010;**153**:829-42.
13
- 14 26 Sargent MC, Sotile W, Sotile MO, Rubash H, Barrack RL. Quality of Life During
15 Orthopedic Training and Academic Practice Part 1: Orthopedic Surgery Residents
16 and Faculty. *J Bone Joint Surg Am* 2009;**91A**:2395-405.
17
- 18 27 Fletcher KE, Underwood W, Davis SQ, Mangrulkar RS, McMahon LF, Saint S.
19 Effects of work hour reduction on residents' lives - A systematic review. *JAMA*
20 2005;**294**:1088-100.
21
22
- 23 28 Black C, Frost D. *Health at work - an independent review on sickness absence*.
24 London: The Stationary Office, 2011.
25
- 26 29 Waddell G, Burton K. *Is work good for your health and wellbeing?* London: The
27 Stationary Office, 2006.
28
- 29 30 Butterworth P, Leach LS, Strazdins L, Olesen SC, Rodgers B, Broom DH. The
30 psychosocial quality of work determines whether employment has benefits for
31 mental health: results from a longitudinal national household panel survey. *Occup*
32 *Environ Med* 2011;**68**:806-12.
33
34
- 35 31 Lockley SW, Landrigan CP, Barger LK, Czeisler CA. When policy meets
36 physiology - The challenge of reducing resident work hours. *Clin Orthop* 2006:116-
37 27.
38
- 39 32 ICD-10. 2012 International Classification of Diseases.
40 <http://www.who.int/classifications/icd/en/>; Access Year 2012.
41
- 42 33 van Uffelen JGZ, Wong J, Chau JY, et al. Occupational Sitting and Health Risks A
43 Systematic Review. *Am J Prev Med* 2010;**39**:379-88.
44
- 45 34 Kirsling RA, Kochar MS, Chan CH. An evaluation of mood states among 1st-year
46 residents. *Psychol Rep* 1989;**65**:355-66.
47
48
- 49 35 Bernard B. A critical review of epidemiologic evidence for work-related
50 musculoskeletal disorders of the neck, upper extremity and low back. In: NIOSH, ed.
51 Publication No. 9741. Cincinnati: National Institute for Occupational Safety and
52 Health, 1997.
53
- 54 36 Steenstra IA, Verbeek JH, Heymans MW, Bongers PM. Prognostic factors for
55 duration of sick leave in patients sick listed with acute low back pain: a systematic
56 review of the literature. *Occup Environ Med* 2005;**62**:851-60.
57
58
59
60

- 1
2
3 37 Ayas NT, Barger LK, Cade BE, et al. Extended work duration and the risk of self-
4 reported percutaneous injuries in interns. *JAMA* 2006;**296**:1055-62.
5
6 38 Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor
7 vehicle crashes among interns. *N Engl J Med* 2005;**352**:125-34.
8
9 39 Firth-Cozens J. Emotional Distress in Junior House Officers. *BMJ* 1987;**295**:533-36.
10
11 40 Fisman DN, Harris AD, Rubin M, Sorock GS, Mittleman MA. Fatigue increases the
12 risk of injury from sharp devices in medical trainees: Results from a case-crossover
13 study. *Infect Control HospEpidemiology* 2007;**28**:10-17.
14
15 41 Hayasaka Y, Nakamura K, Yamamoto M, Sasaki S. Work environment and mental
16 health status assessed by the general health questionnaire in female Japanese doctors.
17 *Ind Health* 2007;**45**:781-86.
18
19 42 Kirkcaldy BD, Trimpop R, Cooper CL. Working hours, job stress, work satisfaction,
20 and accident rates among medical practitioners and allied personnel. *Int J Stress*
21 *Manag* 1997;**4**:79-87.
22
23 43 Rosta J, Aasland OG. Work Hours and Self rated Health of Hospital Doctors in
24 Norway and Germany. A comparative study on national samples. *BMC Health Serv*
25 *Res* 2011;**11**.
26
27 44 Stamp T, Termuhlen P, Miller S, et al. Before and after resident work hour
28 limitations: an objective assessment of the well-being of surgical residents. *Curr*
29 *Surg* 2005;**62**:117-21.
30
31 45 Sundquist J, Johansson SE. High demand, low control, and impaired general health:
32 working conditions in a sample of Swedish general practitioners. *Scand J Pub Health*
33 2000;**28**:123-31.
34
35 46 Varma A, Marott J, Stoltenberg C, Wieclaw J, Kolstad H, Bonde J. With long hours
36 of work, might depression then lurk? A nationwide prospective follow-up study
37 among Danish senior medical consultants. *Scand J Work Environ Health*
38 2012;**38**:418-26.
39
40 47 Zahrai A, Chahal J, Stojimirovic D, Schemitsch EH, Yee A, Kraemer W. Quality of
41 life and educational benefit among orthopedic surgery residents: a prospective,
42 multicentre comparison of the night float and the standard call systems. *Can J Surg*
43 2011;**54**:25-32.
44
45 48 Lindfors PM, Nurmi KE, Meretoja OA, et al. On-call stress among Finnish
46 anaesthetists. *Anaesthesia* 2006;**61**:859-64.
47
48 49 Šelb J, Albrecht T. Mortality rates of medical doctors in Slovenia in 1985 to 1999.
49 *Zdravniški vestnik* 2000:147-148.
50
51 50 Lee S, McCann D, Messenger J. Working Time Around the World: Trends in
52 working hours, laws and policies in a global comparative perspective. Geneva,
53 Switzerland: International Labour Office, 2007.
54
55
56
57
58
59
60

- 1
2
3 51 Elder A, Paterson C. Sharps injuries in UK health care: a review of injury rates, viral
4 transmission and potential efficacy of safety devices. *Occup Med-Oxford*
5 2006;**56**:566-74.
6
7 52 Naghavi SHR, Sanati KA. Needlestick injuries: Does left-handedness matter? *Am J*
8 *Infect Control* 2009;**37**:341-41.
9
10 53 Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury
11 to car occupants: population based case control study. *BMJ* 2002;**324**:1125-28A.
12
13 54 BMA. 2013 European Working Time Directive, [http://bma.org.uk/practical-support-](http://bma.org.uk/practical-support-at-work/ewtd)
14 [at-work/ewtd](http://bma.org.uk/practical-support-at-work/ewtd). Access Date December 2013.
15
16 55 Wilson AM, Weston G. Application of Airline Pilots Hours to Junior Doctors. *BMJ*
17 1989;**299**:779-81.
18
19 56 The European Specialist Medical Qualifications Order 1995. 1995 Statutory
20 Instruments, 1995 No. 3208, MEDICAL PROFESSION, The European Specialist
21 Medical Qualifications Order 1995,
22 <http://legislation.data.gov.uk/uksi/1995/3208/made/data.htm?wrap=true>. Access
23 Date December 2013.
24
25 57 Boorman S. NHS Health and Well-being. The Boorman Review. Leeds, 2009.
26
27 58 Williams S, Michie S, Pattani S. Improving the health of the NHS workforce. Report
28 of the partnership on the health of the NHS Workforce. London: The Nuffield Trust,
29 1998.
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 1. Results of the search strategy, using search engines on PubMed and EMBASE (December 2011) and screening of references lists of identified full papers, study selection and quality assessment.
168x112mm (96 x 96 DPI)



PRISMA 2009 Checklist

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8-9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8-9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8-9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2 for each meta-analysis).	8-9



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10-11
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	17
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-18
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	18-20
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	20-22
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	23-24

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

BMJ Open

European Working Time Directive and doctors' health. A Systematic review of the available epidemiological evidence.

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2014-004916.R1
Article Type:	Research
Date Submitted by the Author:	24-May-2014
Complete List of Authors:	Rodriguez-Jareno, Maria-Cruz; Universitat de Girona, 2. Department of Medical Sciences Demou, Evangelia; University of Glasgow, Institute of Health and Wellbeing Vargas, Sergio; Universitat Pompeu Fabra, Centre for Research in Occupational Health Sanati, Kaveh; University of Glasgow, Institute of Health and Wellbeing Skerjanc, Alenka; University Medical Centre, 6. Clinical Institute of Occupational, Traffic and Sports Medicine Reis, Pedro; 7. College of Occupational Medicine, Portuguese Medical Association Helimaki-Aro, Ritva; 8. Helsinki City Occupational Health Centre, Macdonald, Ewan; University of Glasgow, Institute of Health and Wellbeing Serra, Consol; Universitat Pompeu Fabra, Centre for Research in Occupational Health
Primary Subject Heading:	Health policy
Secondary Subject Heading:	Medical management, Research methods, Health services research, Health policy, Evidence based practice
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

1
2
3 **European Working Time Directive and doctors' health. A Systematic review of the**
4 **available epidemiological evidence.**
5
6

7 **Running title:** Long working hours and doctors' health
8
9

10
11
12 ***Corresponding author**
13

14 Dr. Evangelia Demou
15 Healthy Working Lives Group
16 Institute of Health and Wellbeing
17 University of Glasgow
18 Glasgow, G12 8RZ
19 Tel: +44 141 330 3559
20 E-mail: evangelia.demou@glasgow.ac.uk
21
22

23 Maria Cruz Rodriguez-Jareño^{1,2}, Evangelia Demou^{3,*}, Sergio Vargas-Prada⁴, Kaveh A
24 Sanati^{3,5}, Alenka Škerjanc⁶, Pedro G. Reis⁷, Ritva Helimäki-Aro⁸, Ewan B.
25 Macdonald³, Consol Serra^{1,4,9,10}, on behalf of the UEMS Section of Occupational
26 Medicine¹¹.
27
28
29
30
31

- 32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
1. Catalan and Spanish Societies of Occupational Medicine, Barcelona, Spain.
 2. Department of Medical Sciences. School of Medicine. Universitat de Girona. Girona. Spain
 3. Institute of Health and Wellbeing, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, United Kingdom
 4. CiSAL - Centre for Research in Occupational Health, Universitat Pompeu Fabra, Barcelona, Spain.
 5. Occupational Health Department, Epsom & St Helier University Hospitals NHS Trust, Surrey, United Kingdom
 6. Clinical Institute of Occupational, Traffic and Sports Medicine, University Medical Centre, Ljubljana, Slovenia.
 7. College of Occupational Medicine, Portuguese Medical Association, Lisbon, Portugal.
 8. Helsinki City Occupational Health Centre, Helsinki, Finland.
 9. Occupational Health Service, Parc de Salut MAR, Barcelona, Spain.
 10. CIBER of Epidemiology and Public Health. Spain.
 11. UEMS Section of Occupational Medicine. <http://www.uems-occupationalmedicine.org>

55 Word Count: 4,794
56
57
58
59
60

ABSTRACT

Objective: To summarise the available scientific evidence on the health effects of exposure to working beyond the limit number of hours established by the European Working Time Directive (EWTD) on physicians.

Design: A systematic literature search was conducted in PubMed and Embase. Study selection, quality appraisal and data extraction were carried out by independent pairs of researchers using pre-established criteria.

Setting: Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Participants: The total number of participants was 14,338.

Primary and secondary outcome measures: Health effects classified under the International Classification of Diseases (ICD-10).

Results: Over 3,000 citations and 110 full articles were reviewed. From these, eleven studies of high or intermediate quality carried out in North America, Europe and Japan met the inclusion criteria. Six studies included medical residents, junior doctors or house officers and the five others included medical specialists or consultants, medical, dental and general practitioners and hospital physicians. Evidence of an association was found between percutaneous injuries and road traffic accidents with extended hours/day or very long working weeks (LWH). The evidence was insufficient for mood disorders and general health. No studies on other health outcomes were identified.

Conclusions: LWH could increase the risk of percutaneous injuries and road traffic accidents, and possibly other incidents at work through the same pathway. While associations are clear, the existing evidence does not allow for an established causal or "dose-response" relationship between LWH and incidents at work, or for a threshold number of extended hours above which there is a significantly higher risk and the hours physicians could work and remain safe and healthy. Policy makers should consider safety issues when working on relaxing EWTD for doctors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The first systematic review, to our knowledge, on the effects of Long Working Hours (LWH) on physicians' health and safety.
- A systematic literature search conducted in PubMed and Embase with over 3,000 citations and 110 full articles reviewed.
- Eleven studies of high or intermediate quality carried out in North America, Europe and Japan, involving physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.
- The findings of this review confirmed that long working hours are associated with both an increased risk of needlestick injuries and road traffic accidents. Evidence was assessed as low or insufficient for mood disorders and general health.
- This review uncovered the lack of literature on the effect of long working hours on the general health of doctors, a topic that has important health ramifications not only for physicians but for patients too.

KEY WORDS: Working time, "Physicians"[MeSH], "Morbidity"[MeSH], "Occupational Injuries"[MeSH], Systematic review.

INTRODUCTION

The European Working Time Directive (EWTD),[1] applicable to all occupations across the EU, requires a maximum working week of 48 hours and establishes rest periods.[2, 3] Since it came into force in healthcare in 2009, it has been associated with concerns about the provision of health services including continuity of care, lower staffing levels, introduction of shift working, a reduction in training time and the adequate supervision of junior doctors.[4, 5] The large inter-country variations in physicians working hours as well as the mandatory controls over work hours across occupations raises further questions as to the basis of selecting and setting these limits and restrictions.[6] There is evidence of variable compliance to the EWTD within health care across Europe.[4, 5] The medical profession is also increasingly feminised with potential implications for women of childbearing age, which may coincide with the time in the profession where long working hours (LWH) are more likely to happen (i.e. during residency). Constraint on public-sector finances and increasing health care demands, have stimulated the debate on physicians' working hours,[7] with some evidence showing that the quality of health care is positively correlated with the number of physicians available to deliver that care.[8]

The Union of European Medical Specialists (UEMS) was created in 1958 to represent medical specialists in the EU, promote a high standard of training and practice at European level and facilitate the free movement of physicians across European countries.[9] The Occupational Medicine section was created in 1997 and is involved in issues related to specialist training, professional practice and research;[10] elaborating and publishing reference documents,[11] conducting and contributing to surveys,[12-14] and working in partnership with other key European groups.

The trigger for this project was a request by the Council of the UEMS to its Occupational Medicine Section for a position statement on the EWTD and possible health consequences to physicians of a potential removal of this professional group from the current EWTD 48 hours per week limit.[15-17] An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.[15]

LWH have been associated with several adverse effects on workers' health, such as hypertension, cardiovascular disease, stress, depression, musculoskeletal disorders, chronic infections, diabetes, general health complaints and all-cause mortality in a variety of occupational groups.[18-26] In physicians, there is some evidence suggesting

1
2
3 that LWH can result in impacts such as stress, depression, burnout, injuries, fatigue and
4 sleep deprivation,[27-29] and overwork has been considered one of the most stressful
5 features of physicians' work.[27] Some evidence exists of the beneficial effect of
6 reducing the number of working hours on the quality of life of medical residents [30]
7 and on burnout.[27]
8
9

10
11 However, the relationship between work and health is complex. There is a substantial
12 body of evidence showing that worklessness is associated with poorer health, whereas
13 work is generally good for health and well-being,[31, 32] provided that the work
14 environment is reasonably acceptable and supportive.[33]
15
16
17

18
19 Occupational and non-occupational exposures may play an important role such as the
20 pattern and distribution of working hours, breaks, and recovery periods. Also,
21 psychosocial and organisational factors, such as workload, job control, managers and
22 peer support, training opportunities, individual characteristics and attitudes may be
23 important.[6, 34]
24
25
26

27
28 Finally, physicians are a highly qualified, devoted and motivated professional group.
29 Despite other existing reviews of a more general occupational approach, a review
30 focused on physicians is warranted.
31
32

33
34 The aim of this project was to systematically review whether long-working hours
35 (LWH) -i.e. defined as more than the 48 hour per week limit imposed by the EWTD-
36 are associated with health effects –i.e. classified under the International Classification of
37 Diseases (ICD-10) [35]- in physicians, and to examine what these associations are. This
38 review does not include the potential impact of LWH on patient care or physician
39 training.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

METHODS

The systematic review sought to respond to the following research question: are LWH associated with health effects in physicians? For the purpose of this review, exposure to LWH was defined as working for more than 48 hours per week.[1] Health outcomes included any disease as defined in the ICD-10 [35] and work related injuries. If self-assessed tools on health status were used, only those validated were considered. Burnout, stress and outcomes such as individual symptoms, signs or biological markers (blood pressure, ECG, etc.) were not considered. Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Study identification

Electronic searches were carried out using PubMed and EMBASE as search engines (December 2011). Our search strategy was similar in both databases and consisted of a combination of the following keywords and Mesh terms: night shift, morning shift, evening shift, afternoon shift, shift work, rotating shift, shift combination, shift duration or length, shift system, clockwise rotation, shift roster, extended shifts, night work, evening work, work schedule, work hours, starting time, early start, irregular working hours, direction of rotation, overwork, extended hours, shift rota, workload, work schedule tolerance, sleep deprivation, sleep disorders, chronobiology disorders, circadian rhythm, psychomotor performance, circadian disruption, vigilance, alertness, wakefulness, drowsiness, fatigue, insomnia, hypersomnolence, dyssomnia, eveningness, morningness, neurocognitive performance, concentration difficulties, arousal, health, morbidity, mortality, disease, illness, stress, strain, distress, accident, injur*, death, suicid*, education, medical, physician, medical staff, hospital, doctor, surgeon, house officers, medical school, surgery, surgical.

In addition, the references lists of articles selected for inclusion were carefully reviewed to identify additional studies.

Study selection

1
2
3 Studies were included if they measured the association between the exposure to LWH
4 and health effects in physicians, used an observational epidemiological (i.e. cohort,
5 case-control, cross-sectional) or experimental design. Articles relating to on-call, night
6 or shift work, but with unknown exposure or exposed to less than 48 working hours per
7 week were excluded. They were also excluded if the working groups were other than
8 physicians or addressed only other exposures or outcomes (i.e. patient safety, fatigue,
9 sleep deprivation, social or family disruption). No limitation was set for languages.

10
11 A total of 2,036 citations were obtained from PubMed and 980 non-duplicated citations
12 using Embase, yielding a total of 3,016 citations that were all screened by independent
13 pairs of reviewers. All titles and, where necessary, abstracts were reviewed. Ninety two
14 potentially suitable publications were identified from the electronic searches, and 18
15 further studies were identified from the references lists, yielding a total of 110 studies
16 published in English, French, German, Italian, Slovenian and Spanish. For all of them
17 the full text was obtained and reviewed by independent pairs of reviewers.
18 Disagreements within pairs were resolved by discussion and, where necessary, by a
19 third reviewer who made the final decision. All authors participated as reviewers for
20 screening the citations and full papers using well defined and pre-established criteria.
21 Ninety nine articles were excluded at this stage. One further study was identified that
22 was published after the search period. Finally, 12 papers were considered for quality
23 assessment (Figure 1).

24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
The methodological quality of the 12 studies was assessed by independent pairs of
reviewers. A standardized 16 point scale based on CONSORT and STROBE statements
and adapted from a previous systematic review [36] was used. It includes 16 items
grouped into 6 areas: 1) objectives, 2) study design, 3) target population and sample, 4)
variables, 5) data sources, collection and measurement, and 6) statistical methods. Each
item was rated as 1 (the requirement was met), 0.5 (the requirement was partially met)
or 0 (the requirement was not or unclearly met). Disagreements within pairs of
reviewers were resolved by consensus or, where necessary, by a third reviewer. For
each of the 12 studies, a final score based on the sum of all items was assigned and the
percentage was calculated based on a maximum score of 16. Study quality was rated as
low, moderate or high if it scored less than 60%, between 60% and 79.9%, and 80% or
more of the maximum score, respectively.

1
2
3 One article of low quality was excluded [37] and a total of 11 studies of intermediate or
4 high methodological quality were included for the purpose of this review (figure 1).
5
6
7

8 9 **Data extraction**

10 Selected information was extracted from each paper, including publication year, country
11 of origin, study design, setting, study population, sample size, response rate, measure of
12 working hours, definition used for LWH, health outcomes and their measurement, and
13 main results on point risk estimates or frequencies of health outcomes, and their
14 corresponding 95% confidence interval (95%CI), and whether the analyses were
15 adjusted for potential confounders.
16
17
18
19
20
21

22 23 24 **Evidence synthesis**

25 To summarise the results on the relationship between LWH and health effects, levels of
26 evidence synthesis was performed. This was based on the methodological quality, study
27 design and the consistency of the study outcomes. The following criteria were based on
28 two previous relevant systematic reviews.[38, 39]
29
30
31

32 Strong evidence: consistent results in more than two studies of high quality.
33
34

35 Moderate evidence: consistent results in one high quality study and one intermediate, or
36 between some studies of intermediate quality.
37
38

39 Insufficient evidence: identification of only one study or inconsistent results across
40 studies;
41

42 Evidence of no association: consistent results of a non-association in two or more
43 studies.
44
45

46 A measure of the possible magnitude of the association was attempted using the
47 following criteria based on the association point estimate (RR = relative risk, rate ratio
48 or odds ratio) when available or otherwise the comparison between two frequencies was
49 used:
50
51

- 52 • high: $RR > 3.00$
- 53 • intermediate: $RR = 1.50-3.00$
- 54 • low: $RR = 1.01-1.49$
- 55 • no association: $RR=1.00$
- 56
- 57
- 58
- 59
- 60

- unclear

RESULTS

We identified 11 studies related to LWH and health effects in physicians that were eligible for inclusion. The outcome of the methodological quality assessment is given in table 1.

Methodological quality was appraised as high for 3 of the 11 studies, with scores ranging from 84 to 94%. The other 8 studies were considered as intermediate quality as their scores ranged from 63 to 78%. The majority of all included studies received positive scores on items describing the study objectives, design and the study population (items from areas 1, 2 and 3), as well as the description of exposure and outcome variables (item 4). However, although data sources and collection were well described, reliability and validity of exposure to LWH and health outcome measures had low scores (items 5b and 5c). The statistical methods were in general appropriate, however the confounding variables were not measured in several studies and, as can be seen, the studies did not describe how they addressed missing data (items 6a and 6b).

Study characteristics:

The characteristics of the included studies are described in table 2.

Table 1. Methodological quality appraisal of the included studies

Study ID		Ayas 2006 [40]	Barger 2005 [41]	Firth- Cozens 1987 [42]	Fisman 2007 [43]	Hayasaka 2007 [44]	Kirkcaldy 1997 [45]	Rosta 2011 [46]	Stamp 2005 [47]	Sundquist 2000 [48]	Varma 2012 [49]	Zahrai 2011 [50]
1	Objectives	Are the objectives or hypotheses of the research described in the paper?	1	1	1	1	1	1	1	1	1	1
2	Study design	Is the study design presented?	1	1	1	1	1	1	1	1	1	1
3a	Target population	Do the authors describe the target population they wanted to research?	1	1	1	1	1	1	1	1	1	1
3b	Sample	Was a random sample of the target population taken? AND was the response rate 60% or more?	0.5	0.5	1	0.5	0.5	0.5	1	1	1	0.5
3c	Sample	Is participant selection described?	1	1	1	1	0.5	1	0	1	1	1
3d	Sample	Is participant recruitment described, or referred to?	1	1	1	1	1	1	1	1	1	0
3e	Sample	Are the inclusion and/or exclusion criteria stated?	1	1	1	1	0.5	0.5	1	1	1	0.5
3f	Sample	Is the study sample described? (minimum description: sample size, gender, age and occupation)	1	1	0	1	1	1	0	0	1	1
3g	Sample	Is the number of participants at each stage of the study reported?	1	1	1	0.5	1	0.5	1	1	1	1
4	Variables	Are the measures of long working hours and the health outcome described?	1	1	0.5	1	1	1	1	1	1	1
5a	Data sources, collection	Do authors describe the source of their data (e.g., official registry, health survey) AND how the data were collected?	1	1	1	1	1	1	1	1	1	1
5b	Measurement	Was reliability of the measure(s) of long working hours mentioned or referred to?	0	0	0	1	0	0	0	1	0	0
5c	Measurement	Was the validity of the measure(s) of long working hours mentioned or referred to?	1	1	0	0	0	0	0	0	0	0
5d	Measurement	Were health outcomes assessed by objective measures or validated self-reporting instruments?	0	1	1	1	1	0	1	1	1	1

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

6a	Statistical methods	Were appropriate statistical methods used and described, including those for addressing confounders?	0.5	1	0.5	1	0.5	0.5	1	0.5	1	1	0.5
6b	Statistical methods	Were the numbers/% of participants with missing data for long working hours and the health outcome indicated AND If more than 20% of data in the primary analyses were missing, were methods used to address missing data?	0	0	0	0.5	0	0	0	0	0	1	0.5
Total score** (%)			12.0 (75)	13.5 (84)	11.0 (69)	13.5 (84)	11.0 (69)	10.0 (63)	10.5 (66)	12.5 (78)	12.0 (75)	15.0 (94)	11.0 (69)
Quality rate***			interm	high	interm	high	interm	interm	interm	interm	interm	high	interm

** Maximum score = 16; *** Quality rate (%): low=<60; intermediate (interm)=60-79; high=80-100.

Peer review only

Table 2. Characteristics of the included studies.

Study ID	Country Of Study Population	Design*	Setting	Participants and sample size (response rate)	Working hours	Health outcomes	Quality score (%)
Ayas 2006 [40]	United States	Cohort, prospective (1 year) / Case-crossover	Hospital	Interns in postgraduate residency programs Sample size: 2,737 (80%)	Mean (SD) hrs worked/month: 249.8 (75.3). Self-reported, monthly survey. Strong correlation (Pearson $r=0.76$; $p < 0.001$) with hours worked 244 (69.3) from work diaries of randomly selected subset of 192 interns. Extended periods (20 or more consecutive hours) vs. non extended periods (12 hrs or less consecutive hours).	Self-reported percutaneous injuries	12.0 (75)
Barger 2005 [41]	United States	Cohort, prospective (1 year)	Hospital	Residents first postgraduate year (interns). Sample size: 2,737 (80%)	Mean (SD) hrs worked/week 70.7 (26.0). Extended shift (≥ 24 hrs) vs. non extended shift (< 24 hours). Self-reported, validated.	Self-reported and documented motor vehicle crashes.	13.5 (84)
Firth Cozens 1987 [42]	United Kingdom	Cohort, prospective (1 year)	Hospital	Junior house officers Sample size: 170 (72%)	Mean number of hours per week = 90.6 hours (include on call). Self-reported.	GHQ-12 (case: score ≥ 2) and SCLDS, self-reported	11.0 (69)
Fisman 2007 [43]	United States and Canada	Case-Crossover	Hospital	Medical trainees vs. other HCW. Sample size: 109 vs. 241 (46%)	Median number of hours per week: medical trainees = 70; other HCW = 40 ($p < 0.001$). Self-reported, high reliability.	Reported percutaneous injuries to employee health care service.	13.5 (84)
Hayasaka 2007 [44]	Japan	Cross-sectional	Hospital, clinics, other	Female physicians Sample size: 367 (63%)	Comparison of increasing number of hrs/week from ≤ 30 to > 50 , self-reported.	GHQ-30 (case: score ≥ 8), self-reported	11.0 (69)
Kirkcaldy 1997 [45]	Germany	Cross-sectional	Not specified	Medical and dental practitioners. Sample size: 2,500 (not specified)	Long hours: mean 58.36 hrs/week SD 9.16 Short hours: mean 38.17 hrs/week SD 7.72 Self-reported.	Self-reported traffic accidents	10.0 (63)
Rosta 2011 [46]	Germany and Norway	Cross-sectional	Hospital	Hospital physicians Participants: 1,917 (58%) in Germany and 1,072 (65%) in Norway answered the questionnaire. From survey responders, 1,260 (65.7%) Germans and 562 (52.4) Norwegians were included in the analysis after applying further inclusion criteria.	German vs. Norwegian physicians (%): Hours per day > 9 = 58.8 vs. 26.7 60 hours on-call per month = 63.4 vs. 18.3 Self-reported.	Validated questionnaire on self-rated health	10.5 (66)
Stamp 2005 [47]	United States	Before-and-after	Hospital	Residents of general surgery Sample size: 28 (97%)	Changes of work patterns, after reduction from 90-110 to 78-80 work hrs/week.	SF-36, mental health; BDI, depression; self-reported	12.5 (78)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Sundquist 2000 [48]	Sweden	Cross-sectional	Primary care	General practitioners Sample size: 1,004 (72%)	Overtime defined as working at least 47 hrs/week. Self-reported.	Swedish SF-36, impaired mental health, self-reported	12.0 (75)
Varma 2012 [49]	Denmark	Cohort, prospective (20 months)	Hospital	Senior medical consultants Sample size: 2,790 (62%)	Long work hours (>40hrs/week). Self-reported.	Depression: redemption of anti-depressive drug prescriptions	15.0 (94)
Zahrai 2011 [50]	Canada	Cohort, prospective (6 months)	Hospital	Orthopaedic surgery residents Sample size: 16 (not specified)	Night float (n=9): 77.8% did >80h/week at baseline; 71.4% at follow-up. Standard call (n=7): 57.1% did >80h week at baseline; 80% at follow-up.	SF-36, mental health score, self-reported	11.0 (69)

* Follow-up period in brackets for prospective cohort studies; GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Five had been carried out in North America (4 in the United States [40, 41, 43, 47] and 1 in Canada [50]), five in European countries (Denmark,[49] Germany,[45] Norway and Germany [43]; Sweden,[48] and the United Kingdom [42]) and one study in Japan.[44] Four used a prospective cohort design (follow-up ranging from 6 to 20 months), 2 were case-crossover, 4 cross-sectional, and 1 was a before and after study. Overall, the total number of participants was 14,338 and included medical residents, junior doctors or house officers only working in hospitals, medical specialists or consultants, medical and dental practitioners, general practitioners, hospital physicians and one study included female physicians from a community service. Most studies (n=9) compared different working hour patterns within the same group of physicians, one compared physicians from two different countries,[46] and one included other health care workers as the comparison group.[43]

LWH was defined as more than 48hours/week in most studies, and some did not provide a definition. Two studies considered LWH below 48/week.[46, 48] All the included studies investigated health effects associated with working more than 48h/week, with number of hours ranging between <30 to 110hours/week. One paper studied the effects of an increasing number of hours from 30 to more than 50h/week.[44] Others studied more than 40h/week,[49] 47h/week,[48] above 58h/week [46](two studies) and 6 studies referred to more than 70h/week,[40-43, 47, 50] one of which compared 78-80h/week to 90-110 weekly hours.[47] Information on working hours was self-reported in nine studies, with reasonably good validity only in two studies [40, 41] and reliability in one.[43] In the other two studies it was obtained from established work schedules.[47, 50]

Identified health outcomes that fulfilled the inclusion criteria were percutaneous injuries, motor vehicle accidents, mood disorders and general health. Information was self-reported in all studies using well known validated questionnaires, except three studies that used documented information on motor vehicle crashes,[40] reported percutaneous injuries [42] and antidepressant prescription data as a surrogate of depression.[49]

Summary of findings:

Table 3 shows the findings from each of the 11 studies.

Table 3. Results on the association between long working hours and identified health effects in physicians.

Health outcome	Main results	Adjustment by confounders	Study ID
Percutaneous injuries	Odds ratio (95% CI) for injuries during extended (>20 hours/day) vs. non extended periods (first 12 hours at work): All percutaneous injuries: 1.61 (1.46-1.78); Injuries reported to OH: 1.83 (1.48-2.28); Injuries in the ICU: 1.87 (0.69-5.04); Injuries in the operating room or labour and delivery: 1.77 (1.49-2.09); Injuries in the ICU, non-ICU, or ED: 2.17 (1.56-3.00)	Time of day and circadian influences	Ayas 2006[40]
Percutaneous injuries	Medical trainees vs. other health care workers: total median working hours: 70 vs. 40 hours (p<.001); median previous working hours at the time of injury: 6.5 vs. 5 hours (p<.001). Odds ratio (95% CI) for self-reported fatigue: work > 40h in the past week: 3.50 (2.06-5.92); work during more than 5d in past week: 4.20 (4.46-7.15); >12h at work before injury: 8.58 (3.7-19.86). Incidence rate ratio (95%CI) for association between fatigue and injuries: all workers: 1.40 (1.03-1.90); medical trainees: 2.94 (1.71-5.07); other HCWs: 0.97 (0.66-1.42) (p=0.001 for heterogeneity).	Age and sex	Fisman 2007[43]
Motor vehicle accidents	Odds ratios (95% CI), after extended shift (≥ 24hrs) vs. non extended shift (<24 hours): Crashes = 2.3 (1.6-3.3); Near miss accidents = 5.9 (5.4-6.3)	Age and sex	Barger 2005[41]
Motor vehicle accidents	Incidence rates of driving accidents on house visits: Long hours (mean 58.36 hrs/week) = 0.10 (0.31) vs. short hours (mean 38.17 hrs/week) = 0.02 (0.18). p<0.05	Not adjusted	Kirkcaldy 1997[45]
Mood disorders, depression	Hazard ratio (95% CI) hours/week intervals and redemption of anti-depressive drug prescription(reference group: 37-40 h/week): 25-36 h: 0.83 (0.24-2.82); 41-44 h: 0.95 (0.50-1.77); 45-49 h: 0.88 (0.43-1.78); 50-54 h: 0.83 (0.32-2.14); 55-59 h: 0.67 (0.15-2.94); >60 h: 0.48 (0.06-3.68). Cox regression analysis of work hours as a continuous variable: HR=0.93 (0.76-1.13)	Age, sex, marital status, medical specialty, decision authority at work, social support at work, quantitative work demands and previous redemption of AD drug prescription	Varma 2012[49]
Mood disorders, GHQ-30	Prevalence of cases by working time (hours/week) < 30 hours: 35.7% (41/115); >30 to 40 hours: 39.0% (39/100); >40 to 50 hours: 37.7% (26/69); >50 hours: 56.8% (46/81); p=0.0179 Stepwise multiple logistic regression, >50 h/wk. vs. ≤50 h/wk.: parameter 0.635 (p=0.0293)	Marital status, medical facility, position, and night duty.	Hayasaka 2007[44]
Mood disorders, GHQ-12 and SCLDS	No association was found between number of hours worked in a week and depression.	Not adjusted	Firth Cozens 1987[42]
Mood disorders, SF-36	Scores when night float vs. standard call at baseline and follow-up: Mental health mean score (SD): baseline = 57.33 (22.63) vs. 65.71 (7.61); follow up = 52.00 (15.49) vs. 60.80 (11.45); p=0.72 Mental health component summary (SD), baseline = 34.84 (14.06) vs. 40.21 (7.61); follow up = 30.15 (10.71) vs. 42.40 (6.23); p=0.39 Regression analysis: increased number of hours in hospital correlated with significantly lower SF-36 scores in almost all domains.	Not adjusted	Zahrai 2011[50]
Mood disorders, SF-36 and BDI	Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week): Mental health SF-36): no statistically significant improvement Individual questions BDI before and after duty hours limitations, only energy level statistically significant.	Not adjusted	Stamp 2005[47]

Health outcome	Main results	Adjustment by confounders	Study ID
Mood disorders, SF-36	Odds ratio (95% CI) for working 47 hours per week or more: Impaired mental health, men: 1.59 (0.95-2.66); women: 1.86 (1.03-3.37)	Age and amount of time in practice	Sundquist 2000 [48]
General health, SF-36	SF-36: Scores when night float vs. standard call at baseline and follow-up: General health mean score (SD): baseline = 62.11 (17.47) vs. 77.57 (24.25); follow up = 56.43 (24.89) vs. 84.20 (16.50); p=0.41 Physical health component summary (SD): baseline = 46.16 (13.15) vs. 52.01 (13.33); follow up = 39.32 (9.80) vs. 56.15 (2.18); p=0.015 Vitality mean score (SD): baseline = 51.67 (14.58) vs. 51.43 (15.74); follow up = 48.57 (14.92) vs. 51.00 (10.84); p=0.20 Regression analysis demonstrated that the increased number of hours spent in hospital correlated with significantly lower general health, physical function, mental health, role emotional, social function and mental component summary scale scores (all p < 0.05)	Not adjusted	Zahrai 2011 [50]
General health, SF-36	SF-36, BDI: Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week: Physical health: no statistically significant differences.	Not adjusted	Stamp 2005 [47]
General health, SF-36	SF-36: Odds ratio (95% CI) adjusted for age and time in practice, for working 47 hours per week or more: Impaired general health: men = 1.66 (1.00-2.77); women = 1.59 (1.00-3.17)	Age and amount of time in practice	Sundquist 2000 [48]
General health	Self-rated health: Odds ratio (95% CI) of good self-rated health (logistic regression): Norwegian work time pattern**= 1.35 (1.03-1.77); working in Norway = 4.17 (3.02 - 5.73).	Age, sex and country of work	Rosta 2011 [46]

**Not working more than 9 hours a day and having more than 60 hours a month on-call); GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3 *Percutaneous injuries:* One study of high quality and one of intermediate quality, with
4 non-adjusted analyses, showed consistent results in medical trainees. Ayas et al. found
5 an increased risk of percutaneous injuries associated with working more than 20
6 hours/day compared to non-extended hour periods, except in intensive care units;[40]
7 Fisman et al. found an association between self-reported fatigue and the number of
8 working hours at the time of injury and a 3-fold increased risk of sharp injuries in
9 medical trainees compared to other health care workers (median of working hours/week
10 before the injury: 70 vs. 40;p<.001).[43]

11
12
13
14
15
16 *Motor vehicle accidents:* Two studies of high and intermediate quality showed that long
17 working weeks were associated with an at least two-fold increased risk. Barger et al.
18 found adjusted increased risks for car crashes (OR 2.3; 95%CI 1.6-3.3) and near miss
19 accidents (OR 5.9; 95%CI 5.4-6.3) associated with working extended shifts.[41]
20 Kirkcaldy et al. showed that non-adjusted incidence rates of traffic accidents on house
21 visits was five times as much when physicians worked for a mean of 58 hours/week
22 compared to 38 hours/week (p<0.05).[45]

23
24
25
26
27
28 *Mood disorders:* Six studies of intermediate and high quality found contradictory
29 results for mood disorders. Three of them, all of intermediate quality, provided evidence
30 of an association between LWH and mental health problems. The prevalence of GHQ-
31 30 cases was higher for female physicians working above 50 hours/week than for those
32 working 30 or less hours/week (p<0.05).[44] and an increased adjusted risk of impaired
33 mental health was found for men and women general practitioners who worked for 47
34 hours per week or more.[48] Zahrai et al. found that increased number of hours spent by
35 residents in hospital correlated significantly with lower mental health and mental
36 component summary scale scores (SF-36).[50] Three other studies, one of which of
37 high quality, did not find an association between depression or mood disorders and
38 LWH. Varma et al. did not find higher adjusted risks of depression associated with
39 increased number of hours in senior medical consultants, even when they worked for
40 more than 60 hours per week.[49] Depression or mood disorders measured with GHQ-
41 12, SCLDS or BDI, all validated tools for mental health, were not associated with
42 increased number of working hours [42] nor improved after decreasing the number of
43 hours from 90-110 to 78-80 hours per week in residents.[47]

44
45
46
47
48
49
50
51
52
53
54
55
56 *General health:* Four studies of intermediate quality analysed the association between
57 LWH and general health. Zahrai et al. found that increased number of hours spent by
58
59
60

residents in hospital correlated significantly with poorer general health, physical function and vitality using SF-36.[50] A comparative study of physicians in two different countries found that Norwegians showed higher non-adjusted prevalence of self-reported good health compared to physicians in Germany who worked longer hours.[46] An increased adjusted risk of impaired general health was found for men and women general practitioners who worked for more than 47 hours per week.[48] However, following the implementation of reducing the number of hours from an average of 90-110hours/week to 78-80hours/week did not lead to an overall improvement of residents self-reported physical health.[47]

Synthesis of the evidence:

The levels of evidence synthesis obtained from the analysis of the 11 studies included in this review are shown in table 4.

Table 4. Available scientific evidence on the health problems associated with long working hours in physicians: levels of evidence synthesis.

Health outcome	Degree of evidence*	Magnitude of the association**	Studies ID
Percutaneous injuries	++	++	Ayas 2006[40], Fisman 2007[43]
Motor vehicle accidents	++	++	Barger 2005[41], Kirkcaldy 1997[45]
Mood disorders	+	+/-	Varma 2012[49], Hayasaka 2007[44], Firth Cozens 2001[42], Zahrai 2011[50], Stamp 2005[47], Sundquist 2000[48]
General health	+	+/-	Zahrai 2011[50], Stamp 2005[47], Sundquist 2000[48], Rosta 2011[46]

* Strong evidence (+++): consistent results in more than 2 studies of high quality; Moderate evidence (++) : consistent results in two studies of high quality, or one high quality study and one intermediate, or between some studies of intermediate quality; Insufficient evidence (+): identification of only one study or inconsistent results across studies; Evidence of no association (-): consistent results of a non-association in two or more studies.

** Magnitude of the association: it refers to the magnitude of the association point estimate (RR = relative risk, rate ratio or odds ratio): high (+++) if RR > 3; intermediate (++) if RR = 1.5-3; low (+) if RR < 1.5; no association (-); unclear (+/-).

1
2
3 There is moderate evidence of an association between LWH and percutaneous and
4 motor vehicle accidents in physicians. This evidence comes from one study of high
5 quality and another of intermediate quality both for percutaneous injuries, and for motor
6 vehicle accidents and the magnitude of this association could be intermediate.
7
8

9
10 For mood disorders and general health there is a low or insufficient level of evidence of
11 an association with LWH in physicians. This comes from 6 studies on mood disorders
12 and 4 on general health of high and intermediate methodological quality and
13 inconsistent results among them. No conclusion can be drawn about the magnitude of
14 such associations if existed.
15
16
17
18
19

20 21 **DISCUSSION**

22
23 This review found moderate scientific evidence for a positive association of
24 intermediate magnitude between exposure to LWH and percutaneous injuries and motor
25 vehicle accidents in physicians. Evidence was assessed as low or insufficient for mood
26 disorders and general health.
27
28
29

30
31 To our knowledge, this is the first systematic review on the effects of LWH on
32 physicians' health and safety. The extensive searches were restricted to indexed
33 journals. We systematically identified, selected and assessed the methodological quality
34 of studies by means of independent pairs of reviewers. The quality assessment form and
35 the levels of evidence used in this review were based on CONSORT and STROBE
36 statements and on previous systematic reviews.[36, 38, 39] To give some estimate of
37 the potential magnitude of the effect, we added levels based on the point estimates of
38 measures of association provided by the studies. However, such levels had not been
39 previously established.
40
41
42
43
44
45
46
47

48 **Strengths and limitations of the studies**

49
50 Four studies had a longitudinal prospective design, however only two of them used a
51 robust methodology. Two other studies used a crossover design, which reduces the
52 likelihood of individual variability and confounding, and were considered well
53 designed. Four studies, all rated as intermediate methodological quality, were cross
54 sectional in design and therefore it is difficult to draw causal relationships from them.
55
56
57
58
59
60

1
2
3 Although reverse causality cannot be ruled out from cross-sectional designs, it is
4 unlikely that poorer health determines longer working hours than their healthier peers.
5 One study used a quasi-experimental design but lacked a control group. Also, because
6 of different designs used across the included studies, different estimates of the effects
7 were used that may not be directly comparable.
8
9

10
11 Other limitations include the variability, validity and reliability of working hours, which
12 in most studies was self-reported. Although only those papers specifying the number of
13 working hours were accepted, shift and night work might have worked as confounders
14 too, as it is difficult to acknowledge which proportion of the health effects observed was
15 due exclusively to the LWH component and not due, for instance, to stress, fatigue or
16 sleep deprivation. Moreover, the studies did not discriminate between time spent
17 actively working or asleep while on call, though the EWTD considers all hours on call
18 as working time. Likewise, it is possible that participants were aware that the study was
19 conducted to assess associations between the number of hours worked and health
20 outcomes. Therefore, there might be a volunteer bias in those doctors who work
21 extended hours. To minimise this bias, a case-cross over analysis has been performed in
22 three of the included study [40, 41, 43].
23
24
25
26
27
28
29
30
31

32 Health outcomes were measured mainly based upon self-report, with the exception of
33 documented motor vehicle crashes,[40] reported percutaneous injuries [42] and register-
34 notified anti-depressive drug prescriptions.[48] No studies with other objective
35 measures of health (e.g., mortality) or mental disease (e.g., hospital data) were
36 identified. However, self-reported or perceived health was assessed by validated and
37 widely used instruments, especially when health status (general, mental or physical
38 health) or ill-health symptoms are evaluated. Nonetheless, this raises the possibility that
39 the observed associations might reflect differences in propensity to report health
40 problems when they occur rather than true differences in the risk of worse health status.
41 We cannot rule this out, but the higher propensity for reporting among those who work
42 for longer hours and poorer work schedule patterns would have to relate specifically to
43 the reporting of ill-health rather than non-ill health. It seems unlikely that major
44 differences in propensity to report would extend to a more concrete outcome.
45
46
47
48
49
50
51
52
53

54 The majority of the studies of this review took into account confounding variables in
55 their analyses, such as sex and age. However, none of the studies analysed the potential
56 effect of modifying factors, such as psychosocial aspects at work, including attitudes,
57
58
59
60

1
2
3 motivation, job requirements, demands and content, organisational climate, social
4 relationships at work, work satisfaction, supportive organisation, or the relative number
5 of physicians and other staff available for patient care. Neither were important aspects
6 outside of work, such as life events or lifestyles, taken into account. The study of
7 Japanese female physicians found significant differences by marital status with higher
8 GHQ scores for those who were married.[44] There are significant differences in the
9 number of physicians per capita across different countries and this together with the
10 structure and organisation of health services are potential confounders too that were not
11 addressed in the selected studies across countries.
12
13
14
15
16
17
18

19 A relevant outcome from this review would be to establish a threshold number of
20 extended hours above which there is a significantly higher risk. There is a lack of
21 evidence for a dose-response relationship and nor does the evidence give any indication
22 for a threshold number of hours that physicians could work and remain safe and healthy.
23
24

25 Finally, the heterogeneity of the included studies did not allow a more quantitative
26 synthesis, and a level of evidence approach was used instead.
27
28
29
30
31

32 **Comparison with other studies**

33
34 Our findings of an association between LWH and injuries and accidents in physicians
35 are consistent with research in other occupational groups. Dembe et al. carried out a
36 longitudinal survey in the US including more than 10,000 workers from a variety of
37 occupations and settings.[19] A strong dose-response effect (adjusted for age, gender,
38 occupation, industry and region) was found between LWH and injuries above 40h/week
39 and 8h/day; jobs with overtime schedules were associated with a 61% higher injury
40 hazard rate compared to jobs without overtime; working at least 12 hours per day was
41 associated with a 37% increased hazard rate, and working at least 60 hours per week
42 was associated with a 23% increased hazard rate. They concluded that LWH might
43 indirectly precipitate workplace injuries through a causal process by inducing fatigue or
44 stress in workers. In a separate study assessing injury risks to health care personnel,
45 Dembe et al. demonstrated that the risk of injury when working overtime or at least 60 h
46 per week among physicians and nurses was statistically significant.[51] In our review
47 we found that information about the length of shift work varied across studies, some
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 analysing shifts of up to twenty four hours. Work that included such shifts was more
4 strongly associated with accidents and injuries.[40, 41]
5

6
7 We found insufficient evidence of an association between LWH and mood disorders,
8 other diseases and general health in physicians, despite some scientific evidence
9 suggesting that LWH increase morbidity and mortality in other occupations.[19-26]
10

11
12 Possible explanations for these inconsistencies might be the scarcity of high quality
13 research, and the fact that some of the included papers did not fully address the effect of
14 confounding factors, and the possibility that working as a physician might have a
15 protective effect by itself, for instance through higher motivation and social recognition
16 relative to other occupations.
17

18
19 Stamp et al., in the only before and after study, did not find significant differences for
20 mood disorder or general health before and after implementing requirements to reduce
21 working schedules to 80h/week in residents.[47] It is debatable, however, whether any
22 conclusions can be drawn from the impact of reducing extremely high working hours
23 (90-110hours/week) to very high working hours (78-80hours/week).
24
25

26
27 Although we searched for and identified literature describing associations between
28 LWH and increased mortality in doctors,[52, 53] none of those studies specified the
29 number of hours worked, and therefore were not included.
30

31 32 33 34 35 36 37 38 **Recommendations for future research**

39
40 Further research, including well designed prospective and retrospective longitudinal
41 studies, is needed in this field to establish on scientific grounds what number of hours
42 are safe, both to patients and physicians. Also studies on long term health effects should
43 be considered.
44

45
46 This review was aimed to study exclusively possible detrimental health effects of LWH
47 (more than 48 hours per week) to physicians. Other systematic reviews should be
48 conducted addressing issues, such as the impact of working hours on doctor's well-
49 being and quality of life, the quality of junior doctors training, the quality and continuity
50 of care and impact on patient safety. Also, from a staffing perspective, the economic
51 and social burden of sick leave and physicians leaving the profession are important
52 issues that were beyond the scope of this review and that should be considered in future
53
54
55
56
57
58
59
60

1
2
3 research. Other established criteria [54] that working hours should be 'family friendly',
4 promote gender equality, enhance productivity or facilitate worker choice and influence
5 over working hours, were not addressed. Further research is needed in these other areas.
6
7

8 9 **Conclusions**

10
11 The findings of this review have confirmed that long working hours are associated with
12 both an increased risk of needlestick injuries and road traffic accidents. The fact that
13 these associations are labelled moderate in this review, should not preclude safety
14 procedures and measures being assessed and reassessed to ensure maximum physician
15 and patient safety. The reduction of needlestick injuries requires improved use of safe
16 sharp devices, compliance with safe working procedures, training and regular audits of
17 working practices, particularly for junior doctors who are at greatest risk of needlestick
18 injuries, possibly due to inadequate training.[55, 56] The risk of road traffic accidents
19 could be reduced by discouraging driving after very long shifts (more than 16 hours)
20 and where there is sleep deprivation.[57] Transport should be provided by the employer
21 in these situations. This is a pragmatic recommendation which recognises that long
22 working hours have not been eliminated as a result of the EWTD.
23
24

25
26 This review uncovered the lack of literature on the effect of long working hours on the
27 general health of doctors, a topic that has important health ramifications not only for
28 physicians but for patients too. However, the paucity of available studies, which does
29 not allow for a causal or dose-response relationship to be established, raises further
30 questions about the evidence-base of the current 48 hour limit, especially as this is not
31 enforced strictly and junior doctors, for example in the UK, may opt-out.[58] It may be
32 relevant that the EWTD was not based entirely on science but also took into account, as
33 does all EU legislation, the views of "social partners".[3]
34
35

36
37 It is likely that the mechanism for these increased health and safety risks is fatigue, and
38 our finding of increased risk of accidents to staff, may also be associated with increased
39 risk of clinical errors. Patient safety was not the purpose of this review but long working
40 hours are well recognised to cause decrement in performance both in health care and
41 other professions, where the performance of staff can be safety critical, such as airline
42 pilots, and professional drivers.[59]
43
44

45
46 In addition the EWTD has been associated with real concerns about the adequacy of the
47 training of doctors given their reduced exposure to patient care, and the lack of
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 experience of the patient journey, imposed by adherence to the EWTD.[4] This is
4 potentially exacerbated at the same time by the constraints on the overall duration of
5 training imposed by other EU directives.[60] Further reviews of the EWTD, with regard
6 to this unique group of workers, need to take into account other social factors such as
7 the impact on patient care. This is particularly the case when all health care systems are
8 under strain because of burgeoning demands and limited resources.[4]
9
10
11
12

13
14
15 The findings of this systematic review lead to the suggestion of the following guidelines
16 in the event of non-compliance with the EWTD: 1) long shifts should be avoided to
17 protect both physicians' health and patient safety and no shift should be longer than 16
18 hours (and then exceptionally);[28] 2) Physicians should be discouraged from driving
19 after long shifts to reduce the risk of motor accidents;[41, 45] 3) rigorous attention
20 should be paid to reducing the risk of sharps injuries;[40, 43] 4) organisational aspects
21 such as workload and job control, as well as the pattern and distribution of working
22 hours, breaks and recovery periods should be carefully taken into account, in order to
23 avoid fatigue and sleep deprivation that could lead to mistakes and accidents;[61, 62] 5)
24 Physicians should work in supportive psychosocial environments, in teams, and with
25 adequate training and supervision as their wellbeing is important also for the health of
26 their patients.[61, 62]
27
28
29
30
31
32
33
34
35

36 Further research is required to establish any longer term effects such as on mortality and
37 mental health, also the impact of the nature of the work organisation taking into account
38 the psychosocial aspects of the physicians working and non-working lives, and to
39 determine how many hours are safe for physicians to work.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

ACKNOWLEDGMENTS

Leena Isotalo, Trial Search Coordinator at the Cochrane Occupational Safety and Health Review Group, designed and conducted the final search of the evidence using Medline and Embase databases.

FUNDING

The Section of Occupational Medicine of the UEMS provided limited support to the work of all authors (MCR, ED, SVP, KS, AS, PR, RH), with the exception of the senior authors (EBM, CS). The expenses of one meeting of the core group (MCR, SVP, ED, EBM, CS) were also funded by the Section. **Role of funding source:** The Section of Occupational Medicine of the UEMS acted in its role of promoting and contributing to the research in Occupational Medicine.

AUTHORS' CONTRIBUTIONS:

Mari Cruz Rodríguez-Jareño, Evangelia Demou, Sergio Vargas-Prada, Alenka Škerjanc, Kaveh A Sanati, Ewan B. Macdonald and Consol Serra conceived and submitted the design, carried out the acquisition of data, analysis and interpretation of data, drafted the article and revised it.

Pedro G. Reis and Ritva Helimäki-Aro contributed to acquisition of data, analysis and interpretation of data, drafted the article and revised it.

All authors gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

CONFLICT OF INTERESTS

None. No financial relationships with any organisations that might have an interest in the submitted work, and no other relationships or activities that could appear to have influenced the submitted work.

DATA SHARING STATEMENT

No additional data are available

ETHICS COMMITTEE APPROVAL was not sought as no patients were involved in this study.

REFERENCES

- 1 EUR-Lex. Directive 2003/88/EC of the European Parliament and of the Council of 4 November 2003 concerning certain aspects of the organisation of working time. In: Union OJotE, ed. Brussels: Official Journal of the European Union, 2003.
- 2 EPHA. 2012 EPHA Briefing on the European Working Time Directive (EWTD) http://www.ephpa.org/IMG/pdf/EPHA_Briefing_EWTD_Oct2012_FINAL.pdf; Access Year 2012.
- 3 European Commission. 2013 Working Conditions-Working Time Directive. <http://ec.europa.eu/social/main.jsp?catId=706&langId=en&intPageId=205>; Access Date December 2013.
- 4 House J. Calling time on doctors' working hours. *Lancet* 2009;**373**:2011-12.
- 5 The Lancet. Doctors' training and the European Working Time Directive. *Lancet* 2010;**375**:2121.
- 6 Leff D, Aziz O, Darzi A. Trucks, planes, and scalpels - Is there an evidence-based approach to surgeons' working hours? *Arch Surg* 2007;**142**:817-20.
- 7 Parthasarathy S. Sleep and the medical profession. *Curr Opin Pulm Med* 2005;**11**:507-12.
- 8 Dr. Foster Hospital Guide. 2011 www.drfoosterhealth.co.uk; Access Date February 2011.
- 9 UEMS. 2012 The Union of European Medical Specialists. www.uems.net; Access Year 2012.
- 10 Macdonald EB, Ritchie KA, Murray KJ, et al. Requirements for occupational medicine training in Europe: a Delphi study. *Occup Environ Med* 2000;**57**:98-105.
- 11 Macdonald E, Baransky B, Wilford J. Occupational Medicine in Europe: Scope and Competencies. In: Health WECfEa, ed. Health, Environment and Safety in Enterprises Series n. 3. Bilthoven, The Netherlands, 2000.
- 12 Ballester M, Cordell N, Rodriguez Jareno MC, et al. A European survey of professional bodies representing occupational medicine specialists. *Occup Med (Oxf)* 2012;**62**:366-70.
- 13 Cashman C, Slovak A. The occupational medicine agenda: Routes and standards of specialization in occupational medicine in Europe. *Occup Med (Oxf)* 2005;**55**:308-11.
- 14 De Schryver A, Claesen B, Meheus A, et al. European survey of hepatitis B vaccination policies for healthcare workers. *Eur J Public Health* 2011;**21**:338-43.
- 15 Rodriguez-Juareno M, Serra C, Demou E, et al. European Working Time Directive: systematic review for evidence based decision making. SUMMARY REPORT. In:

- 1
2
3 Medicine USoO, ed. http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%20%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf; UEMS Section of Occupational Medicine, 2011.
- 4
5
6
7
8
9 16 UEMS. 2010 The Newsletter of European Medical Specialists.
10 http://www.uems.eu/data/assets/pdf_file/0014/1463/1466.pdf.
- 11
12 17 UEMS. Meetings of the Board & Council of UEMS- Report. In: European Union of
13 Medical Specialists;
14 http://www.uems.eu/data/assets/pdf_file/0011/1235/UEMS_2011.37_-_report_-_UEMS_Council_6-8.10.2010_Napoli.pdf, ed. Napoli (Italy), 2011.
- 15
16
17 18 Bannai A, Tamakoshi A. The association between long working hours and health: A
18 systematic review of epidemiological evidence. *Scand J Work Environ Health* 2013.
- 19
20 19 Dembe AE, Erickson JB, Delbos RG, et al. The impact of overtime and long work
21 hours on occupational injuries and illnesses: new evidence from the United States.
22 *Occup Environ Med* 2005;**62**:588-97.
- 23
24 20 Johnson JV, Lipscomb J. Long working hours, occupational health and the changing
25 nature of work organization. *Am J Ind Med* 2006;**49**:921-9.
- 26
27 21 Kivimaeki M, Batty GD, Hamer M, et al. Using Additional Information on Working
28 Hours to Predict Coronary Heart Disease. *Ann Intern Med* 2011;**154**.
- 29
30 22 Liu Y, Tanaka H, Fukuoka Heart Study G. Overtime work, insufficient sleep, and
31 risk of non-fatal acute myocardial infarction in Japanese men. *Occup Environ Med*
32 2002;**59**:447-51.
- 33
34 23 Sokejima S, Kagamimori S. Working hours as a risk factor for acute myocardial
35 infarction in Japan: case-control study. *BMJ* 1998;**317**:775-80.
- 36
37 24 Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated with
38 long working hours: A review of the current position. *Occup Environ Med*
39 1997;**54**:367-75.
- 40
41 25 Virtanen M, Ferrie JE, Singh-Manoux A, et al. Long working hours and symptoms
42 of anxiety and depression: a 5-year follow-up of the Whitehall II study. *Psychol Med*
43 2011;**41**:2485-94.
- 44
45 26 Virtanen M, Stansfeld SA, Fuhrer R, et al. Overtime work as a predictor of major
46 depressive episode: a 5-year follow-up of the Whitehall II study. *PloS One*
47 2012;**7**:e30719.
- 48
49 27 Gopal R, Glasheen JJ, Miyoshi TJ, et al.. Burnout and internal medicine resident
50 work-hour restrictions. *Arch Intern Med* 2005;**165**:2595-600.
- 51
52 28 Reed DA, Fletcher KE, Arora VM. Systematic Review: Association of Shift Length,
53 Protected Sleep Time, and Night Float With Patient Care, Residents' Health, and
54 Education. *Ann Intern Med* 2010;**153**:829-42.
- 55
56
57
58
59
60

- 1
2
3 29 Sargent MC, Sotile W, Sotile MO, et al. Quality of Life During Orthopedic Training
4 and Academic Practice Part 1: Orthopedic Surgery Residents and Faculty. *J Bone*
5 *Joint Surg Am* 2009;**91A**:2395-405.
6
- 7 30 Fletcher KE, Underwood W, Davis SQ, et al. Effects of work hour reduction on
8 residents' lives - A systematic review. *JAMA* 2005;**294**:1088-100.
9
- 10 31 Black C, Frost D. *Health at work - an independent review on sickness absence*.
11 London: The Stationary Office, 2011.
12
- 13 32 Waddell G, Burton K. *Is work good for your health and wellbeing?* London: The
14 Stationary Office, 2006.
15
- 16 33 Butterworth P, Leach LS, Strazdins L, et al. The psychosocial quality of work
17 determines whether employment has benefits for mental health: results from a
18 longitudinal national household panel survey. *Occup Environ Med* 2011;**68**:806-12.
19
- 20 34 Lockley SW, Landrigan CP, Barger LK, et al. When policy meets physiology - The
21 challenge of reducing resident work hours. *Clin Orthop* 2006:116-27.
22
- 23 35 ICD-10. 2012 International Classification of Diseases.
24 <http://www.who.int/classifications/icd/en/>; Access Year 2012.
25
- 26 36 van Uffelen JGZ, Wong J, Chau JY, et al. Occupational Sitting and Health Risks A
27 Systematic Review. *Am J Prev Med* 2010;**39**:379-88.
28
- 29 37 Kirsling RA, Kochar MS, Chan CH. An evaluation of mood states among 1st-year
30 residents. *Psychol Rep* 1989;**65**:355-66.
31
- 32 38 Bernard B. A critical review of epidemiologic evidence for work-related
33 musculoskeletal disorders of the neck, upper extremity and low back. In: NIOSH, ed.
34 Publication No. 9741. Cincinnati: National Institute for Occupational Safety and
35 Health, 1997.
36
- 37 39 Steenstra IA, Verbeek JH, Heymans MW, et al. Prognostic factors for duration of
38 sick leave in patients sick listed with acute low back pain: a systematic review of the
39 literature. *Occup Environ Med* 2005;**62**:851-60.
40
- 41 40 Ayas NT, Barger LK, Cade BE, et al. Extended work duration and the risk of self-
42 reported percutaneous injuries in interns. *JAMA* 2006;**296**:1055-62.
43
- 44 41 Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor
45 vehicle crashes among interns. *N Engl J Med* 2005;**352**:125-34.
46
- 47 42 Firth-Cozens J. Emotional Distress in Junior House Officers. *BMJ* 1987;**295**:533-36.
48
- 49 43 Fisman DN, Harris AD, Rubin M, et al. Fatigue increases the risk of injury from
50 sharp devices in medical trainees: Results from a case-crossover study. *Infect*
51 *Control HospEpidemiology* 2007;**28**:10-17.
52
53
54
55
56
57
58
59
60

- 1
2
3 44 Hayasaka Y, Nakamura K, Yamamoto M, et al. Work environment and mental
4 health status assessed by the general health questionnaire in female Japanese doctors.
5 *Ind Health* 2007;**45**:781-86.
6
- 7 45 Kirkcaldy BD, Trimpop R, Cooper CL. Working hours, job stress, work satisfaction,
8 and accident rates among medical practitioners and allied personnel. *Int J Stress*
9 *Manag* 1997;**4**:79-87.
10
- 11 46 Rosta J, Aasland OG. Work Hours and Self rated Health of Hospital Doctors in
12 Norway and Germany. A comparative study on national samples. *BMC Health Serv*
13 *Res* 2011;**11**.
14
- 15 47 Stamp T, Termuhlen P, Miller S, et al. Before and after resident work hour
16 limitations: an objective assessment of the well-being of surgical residents. *Curr Surg*
17 2005;**62**:117-21.
18
- 19 48 Sundquist J, Johansson SE. High demand, low control, and impaired general health:
20 working conditions in a sample of Swedish general practitioners. *Scand J Pub Health*
21 2000;**28**:123-31.
22
- 23 49 Varma A, Marott J, Stoltenberg C, et al. With long hours of work, might depression
24 then lurk? A nationwide prospective follow-up study among Danish senior medical
25 consultants. *Scand J Work Environ Health* 2012;**38**:418-26.
26
- 27 50 Zahrai A, Chahal J, Stojimirovic D, et al. Quality of life and educational benefit
28 among orthopedic surgery residents: a prospective, multicentre comparison of the
29 night float and the standard call systems. *Can J Surg* 2011;**54**:25-32.
30
- 31 51 Dembe AE, Delbos R, Erickson JB. Estimates of injury risks for healthcare
32 personnel working night shifts and long hours. *Quality & Safety in Health Care*
33 2009;**18**:336-40.
34
- 35 52 Lindfors PM, Nurmi KE, Meretoja OA, et al. On-call stress among Finnish
36 anaesthetists. *Anaesthesia* 2006;**61**:859-64.
37
- 38 53 Šelb J, Albreht T. Mortality rates of medical doctors in Slovenia in 1985 to 1999.
39 *Zdravniški vestnik* 2000:147-148.
40
- 41 54 Lee S, McCann D, Messenger J. Working Time Around the World: Trends in
42 working hours, laws and policies in a global comparative perspective. Geneva,
43 Switzerland: International Labour Office, 2007.
44
- 45 55 Elder A, Paterson C. Sharps injuries in UK health care: a review of injury rates, viral
46 transmission and potential efficacy of safety devices. *Occup Med-Oxford*
47 2006;**56**:566-74.
48
- 49 56 Naghavi SHR, Sanati KA. Needlestick injuries: Does left-handedness matter? *Am J*
50 *Infect Control* 2009;**37**:341-41.
51
- 52 57 Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury
53 to car occupants: population based case control study. *BMJ* 2002;**324**:1125-28A.
54
55
56
57
58
59
60

1
2
3 58 BMA. 2013 European Working Time Directive, <http://bma.org.uk/practical-support-at-work/ewtd>. Access Date December 2013.

4
5
6 59 Wilson AM, Weston G. Application of Airline Pilots Hours to Junior Doctors. *BMJ* 1989;**299**:779-81.

7
8
9 60 The European Specialist Medical Qualifications Order 1995. 1995 Statutory
10 Instruments, 1995 No. 3208, MEDICAL PROFESSION, The European Specialist
11 Medical Qualifications Order 1995,
12 <http://legislation.data.gov.uk/uksi/1995/3208/made/data.htm?wrap=true>. Access
13 Date December 2013.

14
15
16 61 Boorman S. NHS Health and Well-being. The Boorman Review. Leeds, 2009.

17
18 62 Williams S, Michie S, Pattani S. Improving the health of the NHS workforce. Report
19 of the partnership on the health of the NHS Workforce. London: The Nuffield Trust,
20 1998.

21 22 **Figure legend**

23
24 **Figure 1.**Results of the search strategy, using search engines on PubMed and EMBASE (December
25 2011) and screening of references lists of identified full papers, study selection and quality assessment.
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7 **European Working Time Directive and doctors' health. A Systematic review of the**
8 **available epidemiological evidence.**
9

10 **Running title:** Long working hours and doctors' health
11

12
13
14 ***Corresponding author**
15

16 Dr. Evangelia Demou
17 Healthy Working Lives Group
18 Institute of Health and Wellbeing
19 University of Glasgow
20 Glasgow, G12 8RZ
21 Tel: +44 141 330 3559
22 E-mail: evangelia.demou@glasgow.ac.uk
23

24 Maria Cruz Rodriguez-Jareño^{1,2}, Evangelia Demou^{3,*}, Sergio Vargas-Prada⁴, Kaveh A
25 Sanati^{3,5}, Alenka Škerjanc⁶, Pedro G. Reis⁷, Ritva Helimäki-Aro⁸, Ewan B.
26 Macdonald³, Consol Serra^{1,4,9,10}, on behalf of the UEMS Section of Occupational
27 Medicine¹¹.
28
29
30
31

- 32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
1. Catalan and Spanish Societies of Occupational Medicine, Barcelona, Spain.
 2. Department of Medical Sciences. School of Medicine. Universitat de Girona. Girona. Spain
 3. Institute of Health and Wellbeing, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, United Kingdom
 4. CiSAL - Centre for Research in Occupational Health, Universitat Pompeu Fabra, Barcelona, Spain.
 5. Occupational Health Department, Epsom & St Helier University Hospitals NHS Trust, Surrey, United Kingdom
 6. Clinical Institute of Occupational, Traffic and Sports Medicine, University Medical Centre, Ljubljana, Slovenia.
 7. College of Occupational Medicine, Portuguese Medical Association, Lisbon, Portugal.
 8. Helsinki City Occupational Health Centre, Helsinki, Finland.
 9. Occupational Health Service, Parc de Salut MAR, Barcelona, Spain.
 10. CIBER of Epidemiology and Public Health. Spain.
 11. UEMS Section of Occupational Medicine. <http://www.uems-occupationalmedicine.org>

51
52 | Word Count: 4,667,794
53
54
55
56
57
58
59
60

ABSTRACT

Objective: To summarise the available scientific evidence on the health effects of exposure to working beyond the limit number of hours established by the European Working Time Directive (EWTD) on physicians.

Design: A systematic literature search was conducted in PubMed and Embase. Study selection, quality appraisal and data extraction were carried out by independent pairs of researchers using pre-established criteria.

Setting: Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Participants: The total number of participants was 14,338.

Primary and secondary outcome measures: Health effects classified under the International Classification of Diseases (ICD-10).

Results: Over 3,000 citations and 110 full articles were reviewed. From these, eleven studies of high or intermediate quality carried out in North America, Europe and Japan met the inclusion criteria. Six studies included medical residents, junior doctors or house officers and the five others included medical specialists or consultants, medical, dental and general practitioners and hospital physicians. Evidence of an association was found between percutaneous injuries and road traffic accidents with extended hours/day or very long working weeks (LWH). The evidence was insufficient for mood disorders and general health. No studies on other health outcomes were identified.

Conclusions: LWH could increase the risk of percutaneous injuries and road traffic accidents, and possibly other incidents at work through the same pathway. While associations are clear, the existing evidence does not allow for an established causal or "dose-response" relationship between LWH and incidents at work, or for a threshold number of extended hours above which there is a significantly higher risk and the hours physicians could work and remain safe and healthy. Policy makers should consider safety issues when working on relaxing EWTD for doctors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The first systematic review, to our knowledge, on the effects of Long Working Hours (LWH) on physicians' health and safety.
- A systematic literature search conducted in PubMed and Embase with over 3,000 citations and 110 full articles reviewed.
- Eleven studies of high or intermediate quality carried out in North America, Europe and Japan, involving physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.
- The findings of this review confirmed that long working hours are associated with both an increased risk of needlestick injuries and road traffic accidents. Evidence was assessed as low or insufficient for mood disorders and general health.
- This review uncovered the lack of literature on the effect of long working hours on the general health of doctors, a topic that has important health ramifications not only for physicians but for patients too.

KEY WORDS: Working time, "Physicians"[MeSH], "Morbidity"[MeSH], "Occupational Injuries"[MeSH], Systematic review.

INTRODUCTION

The European Working Time Directive (EWTD),[1] applicable to all occupations across the EU, requires a maximum working week of 48 hours and establishes rest periods.[2, 3] Since it came into force in healthcare in 2009, it has been associated with concerns about the provision of health services including continuity of care, lower staffing levels, introduction of shift working, a reduction in training time and the adequate supervision of junior doctors.[4, 5] The large inter-country variations in physicians working hours as well as the mandatory controls over work hours across occupations raises further questions as to the basis of selecting and setting these limits and restrictions.[6] There is evidence of variable compliance to the EWTD within health care across Europe.[4, 5] The medical profession is also increasingly feminised with potential implications for women of childbearing age, which may coincide with the time in the profession where long working hours (LWH) are more likely to happen (i.e. during residency). Constraint on public-sector finances and increasing health care demands, have stimulated the debate on physicians' working hours,[7] with some evidence showing that the quality of health care is positively correlated with the number of physicians available to deliver that care.[8]

The Union of European Medical Specialists (UEMS) was created in 1958 to represent medical specialists in the EU, promote a high standard of training and practice at European level and facilitate the free movement of physicians across European countries.[9] The Occupational Medicine section was created in 1997 and is involved in issues related to specialist training, professional practice and research;[10] elaborating and publishing reference documents,[11] conducting and contributing to surveys,[12-14] and working in partnership with other key European groups.

The trigger for this project was a request by the Council of the UEMS to its Occupational Medicine Section for a position statement on the EWTD and possible health consequences to physicians of a potential removal of this professional group from the current EWTD 48 hours per week limit. ~~An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.[15-17]~~
An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.[15]

LWH have been associated with several adverse effects on workers' health, such as hypertension, cardiovascular disease, stress, depression, musculoskeletal disorders,

1
2
3
4
5
6 chronic infections, diabetes, general health complaints and all-cause mortality in a
7 variety of occupational groups.^{[15-23][18-26]} In physicians, there is some evidence
8 suggesting that LWH can result in impacts such as stress, depression, burnout, injuries,
9 fatigue and sleep deprivation,^{[24-26][27-29]} and overwork has been considered one of
10 the most stressful features of physicians' work.^{[24][27]} Some evidence exists of the
11 beneficial effect of reducing the number of working hours on the quality of life of
12 medical residents ^{[27][30]} and on burnout,^{[24][27]}

13
14
15
16 However, the relationship between work and health is complex. There is a substantial
17 body of evidence showing that worklessness is associated with poorer health, whereas
18 work is generally good for health and well-being.^[31, 32] provided that the work
19 environment is reasonably acceptable and supportive.^[33]

20
21
22
23 Occupational and non-occupational exposures may play an important role such as the
24 pattern and distribution of working hours, breaks, and recovery periods. Also,
25 psychosocial and organisational factors, such as workload, job control, managers and
26 peer support, training opportunities, individual characteristics and attitudes may be
27 important.^[6, 34]

28
29
30
31 Finally, physicians are a highly qualified, devoted and motivated professional group.
32 Despite other existing reviews of a more general occupational approach, a review
33 focused on physicians is warranted.

34
35
36 The aim of this project was to systematically review whether long-working hours
37 (LWH) -i.e. defined as more than the 48 hour per week limit imposed by the EWTD-
38 are associated with health effects –i.e. classified under the International Classification of
39 Diseases (ICD-10) ^{[32][35]}- in physicians, and to examine what these associations are.
40 This review does not include the potential impact of LWH on patient care or physician
41 training.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Field Code Changed

Field Code Changed

METHODS

The systematic review sought to respond to the following research question: are LWH associated with health effects in physicians? For the purpose of this review, exposure to LWH was defined as working for more than 48 hours per week.^{[4][1]} Health outcomes included any disease as defined in the ICD-10 ~~[32] and work related injuries.[35] and work related injuries.~~ If self-assessed tools on health status were used, only those validated were considered. Burnout, stress and outcomes such as individual symptoms, signs or biological markers (blood pressure, ECG, etc.) were not considered. Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Study identification

Electronic searches were carried out using PubMed and EMBASE as search engines (December 2011). Our search strategy was similar in both databases and consisted of a combination of the following keywords and Mesh terms: night shift, morning shift, evening shift, afternoon shift, shift work, rotating shift, shift combination, shift duration or length, shift system, clockwise rotation, shift roster, extended shifts, night work, evening work, work schedule, work hours, starting time, early start, irregular working hours, direction of rotation, overwork, extended hours, shift rota, workload, work schedule tolerance, sleep deprivation, sleep disorders, chronobiology disorders, circadian rhythm, psychomotor performance, circadian disruption, vigilance, alertness, wakefulness, drowsiness, fatigue, insomnia, hypersomnolence, dyssomnia, eveningness, morningness, neurocognitive performance, concentration difficulties, arousal, health, morbidity, mortality, disease, illness, stress, strain, distress, accident, injur*, death, suicid*, education, medical, physician, medical staff, hospital, doctor, surgeon, house officers, medical school, surgery, surgical.

In addition, the references lists of articles selected for inclusion were carefully reviewed to identify additional studies.

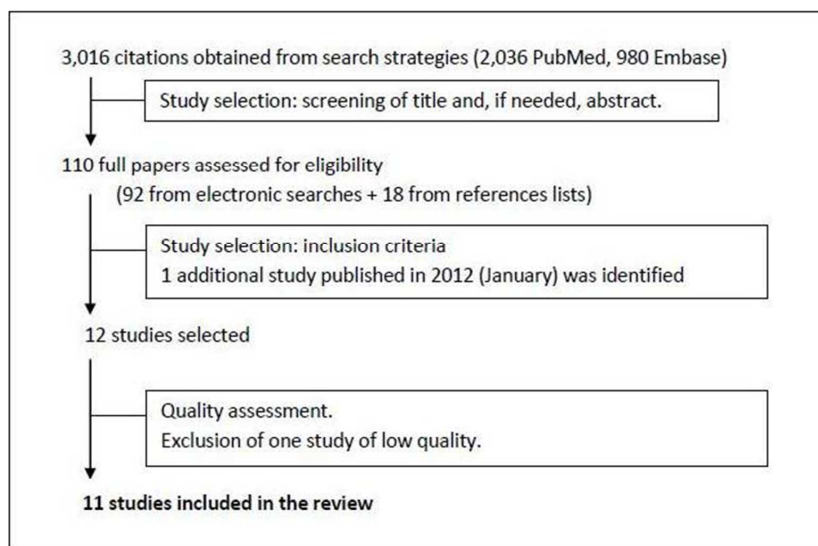
Study selection

6

1
2
3
4
5
6 Studies were included if they measured the association between the exposure to LWH
7 and health effects in physicians, used an observational epidemiological (i.e. cohort,
8 case-control, cross-sectional) or experimental design, ~~and were published in English,
9 French, German, Italian, Slovenian or Spanish.~~ Articles relating to on-call, night or shift
10 work, but with unknown exposure or exposed to less than 48 working hours per week
11 were excluded. They were also excluded if the working groups were other than
12 physicians or addressed only other exposures or outcomes (i.e. patient safety, fatigue,
13 sleep deprivation, social or family disruption). No limitation was set for languages.
14
15
16
17

18 A total of 2,036 citations were obtained from PubMed and 980 non-duplicated citations
19 using Embase, yielding a total of 3,016 citations that were all screened by independent
20 pairs of reviewers. All titles and, where necessary, abstracts were reviewed. Ninety two
21 potentially suitable publications were identified from the electronic searches, and 18
22 further studies were identified from the references lists, yielding a total of 110 studies
23 ~~for all of which published in English, French, German, Italian, Slovenian and Spanish.~~
24 For all of them the full text was obtained and reviewed by independent pairs of
25 reviewers. Disagreements within pairs were resolved by discussion and, where
26 necessary, by a third reviewer who made the final decision. All authors participated as
27 reviewers for screening the citations and full papers using well defined and pre-
28 established criteria. Ninety nine articles were excluded at this stage. One further study
29 was identified that was published after the search period. Finally, 12 papers were
30 considered for quality assessment (Figure 1).
31
32
33
34
35
36
37

38 **Figure 1.** Results of the search strategy, using search engines on PubMed and EMBASE (December
39 2011) and screening of references lists of identified full papers, study selection and quality assessment.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



The methodological quality of the 12 studies was assessed by independent pairs of reviewers. A standardized 16 point scale based on CONSORT and STROBE statements (Table 1) and adapted from a previous systematic review [33] was used. [36] was used. It includes 16 items grouped into 6 areas: 1) objectives, 2) study design, 3) target population and sample, 4) variables, 5) data sources, collection and measurement, and 6) statistical methods. Each item was rated as 1 (the requirement was met), 0.5 (the requirement was partially met) or 0 (the requirement was not or unclearly met). Disagreements within pairs of reviewers were resolved by consensus or, where necessary, by a third reviewer. For each of the 12 studies, a final score based on the sum of all items was assigned and the percentage was calculated based on a maximum score of 16. Study quality was rated as low, moderate or high if it scored less than 60%, between 60% and 79.9%, and 80% or more of the maximum score, respectively.

One article of low quality was excluded [34] and a total of 11 studies of intermediate or high methodological quality were included for the purpose of this review (figure 1).

One article of low quality was excluded [37] and a total of 11 studies of intermediate or high methodological quality were included for the purpose of this review (figure 1).

Data extraction

Selected information was extracted from each paper, including publication year, country of origin, study design, setting, study population, sample size, response rate, measure of working hours, definition used for LWH, health outcomes and their measurement, and

1
2
3
4
5
6 main results on point risk estimates or frequencies of health outcomes, and their
7 corresponding 95% confidence interval (95%CI), and whether the analyses were
8 adjusted for potential confounders.
9

10 11 12 13 **Evidence synthesis**

14 To summarise the results on the relationship between LWH and health effects, levels of
15 evidence synthesis was performed. This was based on the methodological quality, study
16 design and the consistency of the study outcomes. The following criteria were based on
17 two previous relevant systematic reviews,^[3538, 3639]
18

19
20
21 Strong evidence: consistent results in more than two studies of high quality.

22
23 Moderate evidence: consistent results in one high quality study and one intermediate, or
24 between some studies of intermediate quality.
25

26
27 Insufficient evidence: identification of only one study or inconsistent results across
28 studies;

29
30 Evidence of no association: consistent results of a non-association in two or more
31 studies.

32
33 A measure of the possible magnitude of the association was attempted using the
34 following criteria based on the association point estimate (RR = relative risk, rate ratio
35 or odds ratio) when available or otherwise the comparison between two frequencies was
36 used:
37

- 38 • high: $RR > 3.00$
- 39 • intermediate: $RR = 1.50-3.00$
- 40 • low: $RR = 1.01-1.49$
- 41 • no association: $RR=1.00$
- 42 • unclear
- 43
- 44
- 45

46 47 48 **RESULTS**

49 We identified 11 studies related to LWH and health effects in physicians that were
50 eligible for inclusion. The outcome of the methodological quality assessment is given in
51 table 1.
52

53
54 Methodological quality was appraised as high for 3 of the 11 studies, with scores
55 ranging from 84 to 94%. The other 8 studies were considered as intermediate quality as
56

57
58
59
60
9

Field Code Changed

Field Code Changed

1
2
3
4
5
6 their scores ranged from 63 to 78%. The majority of all included studies received
7 positive scores on items describing the study objectives, design and the study
8 population (items from areas 1, 2 and 3), as well as the description of exposure and
9 outcome variables (item 4). However, although data sources and collection were well
10 described, reliability and validity of exposure to LWH and health outcome measures
11 had low scores (items 5b and 5c). The statistical methods were in general appropriate,
12 however the confounding variables were not measured in several studies and, as can be
13 seen, the studies did not describe how they addressed missing data (items 6a and 6b).
14
15
16
17
18
19

20 **Study characteristics:**

21 The characteristics of the included studies are described in table 2.
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1. Methodological quality appraisal of the included studies

Study ID		Ayas 2006 [37][40]	Barger 2005 [38][41]	Firth-Cozens 1987 [39][42]	Fisman 2007 [40][43]	Hayasaka 2007 [41][44]	Kirkcaldy 1997 [42][45]	Rosta 2011 [43][46]	Stamp 2005 [44][47]	Sundquist 2000 [45][48]	Varma 2012 [46][49]	Zahrai 2011 [47][50]
1	Objectives	Are the objectives or hypotheses of the research described in the paper?	1	1	1	1	1	1	1	1	1	1
2	Study design	Is the study design presented?	1	1	1	1	1	1	1	1	1	1
3a	Target population	Do the authors describe the target population they wanted to research?	1	1	1	1	1	1	1	1	1	1
3b	Sample	Was a random sample of the target population taken? AND was the response rate 60% or more?	0.5	0.5	1	0.5	0.5	0.5	1	1	1	0.5
3c	Sample	Is participant selection described?	1	1	1	1	0.5	1	0	1	1	1
3d	Sample	Is participant recruitment described, or referred to?	1	1	1	1	1	1	1	1	1	0
3e	Sample	Are the inclusion and/or exclusion criteria stated?	1	1	1	1	0.5	0.5	1	1	1	0.5
3f	Sample	Is the study sample described? (minimum description: sample size, gender, age and occupation)	1	1	0	1	1	1	0	0	0	1
3g	Sample	Is the number of participants at each stage of the study reported?	1	1	1	0.5	1	0.5	1	1	1	1
4	Variables	Are the measures of long working hours and the health outcome described?	1	1	0.5	1	1	1	1	1	1	1
5a	Data sources, collection	Do authors describe the source of their data (e.g., official registry, health survey) AND how the data were collected?	1	1	1	1	1	1	1	1	1	1
5b	Measurement	Was reliability of the measure(s) of long working hours mentioned or referred to?	0	0	0	1	0	0	0	1	0	0
5c	Measurement	Was the validity of the measure(s) of long working hours mentioned or referred to?	1	1	0	0	0	0	0	0	0	0
5d	Measurement	Were health outcomes assessed by objective measures or validated self-reporting instruments?	0	1	1	1	1	0	1	1	1	1

6a	Statistical methods	Were appropriate statistical methods used and described, including those for addressing confounders?	0.5	1	0.5	1	0.5	0.5	1	0.5	1	1	0.5
6b	Statistical methods	Were the numbers/% of participants with missing data for long working hours and the health outcome indicated AND If more than 20% of data in the primary analyses were missing, were methods used to address missing data?	0	0	0	0.5	0	0	0	0	0	1	0.5
Total score** (%)			12.0 (75)	13.5 (84)	11.0 (69)	13.5 (84)	11.0 (69)	10.0 (63)	10.5 (66)	12.5 (78)	12.0 (75)	15.0 (94)	11.0 (69)
Quality rate***			interm	high	interm	high	interm	interm	interm	interm	interm	high	interm

** Maximum score = 16; *** Quality rate (%): low=<60; intermediate (interm)=60-79; high=80-100.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Table 2. Characteristics of the included studies.

Study ID	Country Of Study Population	Design*	Setting	Participants and sample size (response rate)	Working hours	Health outcomes	Quality score (%)
Ayas 2006 [37] Ayas 2006 [40]	United States	Cross-over Cohort, prospective (1 year) / Case-crossover	Hospital	Interns in postgraduate residency programs Sample size: 2,737 (80%)	Mean (SD) hrs worked/month: 249.8 (75.3-self) . Self-reported, monthly survey. Strong correlation (Pearson $r=0.76$; $p < 0.001$) with hours worked 244 (69.3) from work diaries of randomly selected subset of 192 interns. Extended periods (>20 hrs/day or more consecutive hours) vs. non extended periods (first-12 hrs at work or less consecutive hours).	Self-reported percutaneous injuries	12.0 (75)
Barger 2005 [38] Barger 2005 [41]	United States	Cohort, prospective (1 year)	Hospital	Residents first postgraduate year (interns). Sample size: 2,554 (75/37) (80%)	Average 70.7+26.0 Mean (SD) hrs worked/week: 70.7 (26.0) . Extended shift (≥ 24 hrs) vs. non extended shift (<24 hours). Self-reported, validated.	Self-reported and documented motor vehicle crashes.	13.5 (84)
Firth Cozens 1987 [39] Firth Cozens 1987 [42]	United Kingdom	Cohort, prospective (1 year)	Hospital	Junior house officers Sample size: 170 (72%)	Mean number of hours per week = 90.6 hours (include on call). Self-reported.	GHQ-12 (case: score ≥ 2) and SCLDS, self-reported	11.0 (69)
Fisman 2007 [40] Fisman 2007 [43]	United States and Canada	Cross-over Case-Crossover	Hospital	Medical trainees vs. other HCW. Sample size: 109 vs. 241 (46%)	Median number of hours per week: medical trainees = 70; other HCW = 40 ($p < 0.001$). Self-reported, high reliability.	Reported percutaneous injuries to employee health care service.	13.5 (84)
Hayasaka 2007 [44] Hayasaka 2007 [44]	Japan	Cross-sectional	Hospital, clinics, other	Female physicians Sample size: 367 (63%)	Comparison of increasing number of hrs/week from ≤ 30 to >50 , self-reported.	GHQ-30 (case: score ≥ 8), self-reported	11.0 (69)
Kirkcaldy 1997 [42] Kirkcaldy 1997 [45]	Germany	Cross-sectional	Not specified	Medical and dental practitioners. Sample size: 2,500 (not specified)	Long hours: mean 58.36 hrs/week SD 9.16 Short hours: mean 38.17 hrs/week SD 7.72 Self-reported.	Self-reported traffic accidents	10.0 (63)
Rosta 2011 [43] Rosta 2011 [46]	Germany and Norway	Cross-sectional	Hospital	Hospital physicians Sample size Participants: 1,917 (58%) in Germany and 1,072 (65%) in Norway answered the questionnaire. From survey responders, 1,260 (65.7%) Germans and 562 (52.4%) Norwegians (58% and 65%) were included in the analysis after applying further inclusion criteria.	German vs. Norwegian physicians (%): Hours per day $>9 = 58.8$ vs. 26.7 60 hours on-call per month = 63.4 vs. 18.3 Self-reported.	Validated questionnaire on self-rated health	10.5 (66)

Formatted: Font: (Intl) Arial Unicode MS

Formatted: Font: (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Stamp-2006- [44] Stamp 2005 [47]	United States	Before-and-after	Hospital	Residents of general surgery Sample size: 28 (97%)	Changes of work patterns, after reduction from 90-110 to 78-80 work hrs/week.	SF-36, mental health; BDI, depression; self-reported	12.5 (78)
Sundquist-2000- [45] Sundquist 2000 [48]	Sweden	Cross-sectional	Primary care	General practitioners Sample size: 1,004 (72%)	Overtime defined as working at least 47 hrs/week. Self-reported.	Swedish SF-36, impaired mental health, self-reported	12.0 (75)
Varma-2012- [46] Varma 2012 [49]	Denmark	Cohort, prospective (20 months)	Hospital	Senior medical consultants Sample size: 2,790 (62%)	Long work hours (>40hrs/week). Self-reported.	Depression: redemption of anti-depressive drug prescriptions	15.0 (94)
Zahrai-2014- [47] Zahrai 2011 [50]	Canada	Cohort, prospective (6 months)	Hospital	Orthopaedic surgery residents Sample size: 16 (not specified)	Night float (n=9): 77.8% did >80h/week at baseline; 71.4% at follow-up). Standard call (n=7): 57.1% did >80h week at baseline; 80% at follow-up.	SF-36, mental health score, self-reported	11.0 (69)

* Follow-up period in brackets for prospective cohort studies; GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Five had been carried out in North America (4 in the United States [37, 38, 40, 44][40, 41, 43, 47] and 1 in Canada [50]), five in European countries (Denmark,[49] Germany,[45] Norway and Germany [43]; Sweden,[48] and the United Kingdom [42]) and one study in Japan.[44] Four used a prospective cohort design (follow-up ranging from 6 to 20 months), 2 were case-crossover, 4 cross-sectional, and 1 was a before and after study. Overall, the total number of participants was 14,338 and included medical residents, junior doctors or house officers only working in hospitals, medical specialists or consultants, medical and dental practitioners, general practitioners, hospital physicians and one study included female physicians from a community service. Most studies (n=9) compared different working hour patterns within the same group of physicians, one compared physicians from two different countries,[46] and one included other health care workers as the comparison group.[43]

LWH was defined as more than 48hours/week in most studies, and some did not provide a definition. Two studies considered LWH below 48/week.[46, 48] All the included studies investigated health effects associated with working more than 48h/week, with number of hours ranging between <30 to 110hours/week. One paper studied the effects of an increasing number of hours from 30 to more than 50h/week.[44] Others studied more than 40h/week,[49] 47h/week,[48] above 58h/week [46] (two studies) and 6 studies referred to more than 70h/week,[37, 40, 44, 47][40-43, 47, 50] one of which compared 78-80h/week to 90-110 weekly hours.[47] Information on working hours was self-reported in nine studies, with reasonably good validity only in two studies [37, 38][40, 41] and reliability in one.[43] In the other two studies it was obtained from established work schedules.[44, 47][47, 50]

Identified health outcomes that fulfilled the inclusion criteria were percutaneous injuries, motor vehicle accidents, mood disorders and general health. Information was self-reported in all studies using well known validated questionnaires, except three studies that used documented information on motor vehicle crashes,[40] reported percutaneous injuries [42] and antidepressant prescription data as a surrogate of depression.[49]

Summary of findings:

Table 3 shows the findings from each of the 11 studies.

Table 3. Results on the association between long working hours and identified health effects in physicians.

Health outcome	Main results	Adjustment by confounders	Study ID
Percutaneous injuries	Odds ratio (95% CI) for injuries during extended (>20 hours/day) vs. non extended periods (first 12 hours at work): All percutaneous injuries: 1.61 (1.46-1.78); Injuries reported to OH: 1.83 (1.48-2.28); Injuries in the ICU: 1.87 (0.69-5.04); Injuries in the operating room or labour and delivery: 1.77 (1.49-2.09); Injuries in the ICU, non-ICU, or ED: 2.17 (1.56-3.00)	Not adjusted <u>Time of day and circadian influences</u>	Ayas-2006[37] Ayas-2006[40]
Percutaneous injuries	Medical trainees vs. other health care workers: total median working hours: 70 vs. 40 hours (p<.001); median previous working hours at the time of injury: 6.5 vs. 5 hours (p<.001). Odds ratio (95% CI) for self-reported fatigue: > work > 40h in the past week: 3.550 (2.06-5.92); work during more than 5d in past week: 4.220 (4.46-7.15); >12h at work before injury: 8.58 (3.7-19.86). Incidence rate ratio (95%CI) for <u>association between fatigue and injuries</u> and fatigue: all workers: 1.40 (1.03-1.90); medical trainees: 2.94 (1.71-5.07); other HCWs: 0.97 (0.66-1.42) (p=0.001 for heterogeneity).	Age and sex	Fisman-2007[40] Fisman-2007[43]
Motor vehicle accidents	<u>Relative riskOdds ratios</u> (95% CI), after extended shift (≥ 24hrs) vs. non extended shift (<24 hours): Crashes = 2.3 (1.6-3.3); Near miss accidents = 5.9 (5.4-6.3)	Age and sex	Barger-2006[38] Barger-2005[41]
Motor vehicle accidents	Incidence rates of driving accidents on house visits: Long hours (mean 58.36 hrs/week) = 0.10 (0.31) vs. short hours (mean 38.17 hrs/week) = 0.02 (0.18) vs.-). p<0.05	Not adjusted	Kirkcaldy-1997[42] Kirkcaldy-1997[45]
Mood disorders, depression	Hazard ratio (95% CI) hours/week intervals and redemption of anti-depressive drug prescription(reference group: 37-40 h/week): 25-36 h: 0.83 (0.24-2.82); 41-44 h: 0.95 (0.50-1.77); 45-49 h: 0.88 (0.43-1.78); 50-54 h: 0.83 (0.32-2.14); 55-59 h: 0.67 (0.15-2.94); >60 h: 0.48 (0.06-3.68). Cox regression analysis of work hours as a continuous variable: HR=0.93 (0.76-1.13)	Age, sex, marital status, medical specialty, decision authority at work, social support at work, quantitative work demands and previous redemption of AD drug prescription	Varma-2012[46] Varma-2012[49]
Mood disorders, GHQ-30	Prevalence of cases by working time (hours/week) ≤ 30 hours: 35.7% (41/115); >30 to 40 hours: 39.0% (39/100); >40 to 50 hours: 37.7% (26/69); >50 hours: 56.8% (46/81); p=0.0179 Stepwise multiple logistic regression, >50 h/wk. vs. ≤50 h/wk.: parameter 0.635 (p=0.0293)	Marital status, medical facility, position, and night duty.	Hayasaka-2007[44] Hayasaka-2007[44]
Mood disorders, GHQ-12 and SCLDS	No association was found between number of hours worked in a week and depression.	Not adjusted	Firth-Cozens-1987[39] Firth-Cozens-1987[42]
Mood disorders, SF-36	Scores when night float vs. standard call at baseline and follow-up: Mental health mean score (SD): baseline = 57.33 (22.63) vs. 65.71 (7.61); follow up = 52.00 (15.49) vs. 60.80 (11.45); p=0.72 Mental health component summary (SD), baseline = 34.84 (14.06) vs. 40.21 (7.61) ; follow up = 30.15 (10.71) vs. 42.40 (6.23); p=0.39 Regression analysis: increased number of hours in hospital correlated with significantly lower SF-36 scores in almost all domains.	Not adjusted	Zahrai-2011[47] Zahrai-2011[50]

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Health outcome	Main results	Adjustment by confounders	Study ID
Mood disorders, SF-36 and BDI	Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week); Mental health SF-36): no statistically significant improvement Individual questions BDI before and after duty hours limitations, only energy level statistically significant.	Not adjusted	Stamp-2005[44] Stamp-2005[47]
Mood disorders, SF-36	Odds ratio (95% CI)for working 47 hours per week or more: Impaired mental health, men: 1.59 (0.95-2.66); women: 1.86 (1.03-3.37)	Age and amount of time in practice	Sundquist-2000[45] Sundquist 2000[48]
General health, SF-36	SF-36: Scores when night float vs. standard call at baseline and follow-up: General health mean score (SD): baseline = 62.11 (17.47) vs. 77.57 (24.25); follow up = 56.43 (24.89) vs. 84.20 (16.50); p=0.41 Physical health component summary (SD): baseline = 46.16 (13.15) vs. 52.01 (13.33); follow up = 39.32 (9.80) vs. 56.15 (2.18); p=0.015 Vitality mean score (SD): baseline = 51.67 (14.58) vs. 51.43 (15.74); follow up = 48.57 (14.92) vs. 51.00 (10.84); p=0.20 Regression analysis demonstrated that the increased number of hours spent in hospital correlated with significantly lower general health, physical function, mental health, role emotional, social function and mental component summary scale scores (all p < 0.05)	Not adjusted	Zahrai-2011[47] Zahrai-2011[50]
General health, SF-36	SF-36, BDI: Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week); Physical health: no statistically significant differences.	Not adjusted	Stamp-2005[44] Stamp-2005[47]
General health, SF-36	SF-36: Odds ratio (95% CI) adjusted for age and time in practice, for working 47 hours per week or more: Impaired general health: men = 1.66 (1.00-2.77); women = 1.59 (1.00-3.17)	Age and amount of time in practice	Sundquist-2000[45] Sundquist 2000[48]
General health, SF-36	Self-rated health: Odds ratio (95% CI) of good self-rated health (logistic regression): Norwegian work time pattern**= 1.35 (1.03-1.77); working in Norway = 4.17 (3.02 - 5.73).	Age, sex and country of work	Rosta-2011[43] Rosta-2011[46]

**Not working more than 9 hours a day and having more than 60 hours a month on-call); GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Percutaneous injuries: One study of high quality and one of intermediate quality, with non-adjusted analyses, showed consistent results in medical trainees. Ayas et al. found an increased risk of percutaneous injuries associated with working more than 20 hours/day compared to non-extended hour periods, except in intensive care units;^[37] [Fisman et al.](#)^[40] [Fisman et al.](#) found an association between self-reported fatigue and the number of working hours at the time of injury and a 3-fold increased risk of sharp injuries in medical trainees compared to other health care workers (median of working hours/week before the injury: 70 vs. 40;p<.001),^[4043]

Field Code Changed

Field Code Changed

Motor vehicle accidents: Two studies of high and intermediate quality showed that long working weeks were associated with an at least two-fold increased risk. Barger et al. found adjusted increased risks for car crashes (OR 2.3; 95%CI 1.6-3.3) and near miss accidents (OR 5.9; 95%CI 5.4-6.3) associated with working extended shifts.^[38] [Kirkcaldy et al.](#)^[41] [Kirkcaldy et al.](#) showed that non-adjusted incidence rates of traffic accidents on house visits was five times as much when physicians worked for a mean of 58 hours/week compared to 38 hours/week (p<0.05),^[4245]

Field Code Changed

Field Code Changed

Mood disorders: Six studies of intermediate and high quality found contradictory results for mood disorders. Three of them, all of intermediate quality, provided evidence of an association between LWH and mental health problems. The prevalence of GHQ-30 cases was higher for female physicians working above 50 hours/week than for those working 30 or less hours/week (p<0.05),^{[44][44]} and an increased adjusted risk of impaired mental health was found for men and women general practitioners who worked for 47 hours per week or more.^[45] [Zahrai et al.](#)^[48] [Zahrai et al.](#) found that increased number of hours spent by residents in hospital correlated significantly with lower mental health and mental component summary scale scores (SF-36).^{[47][50]} Three other studies, one of which of high quality, did not find an association between depression or mood disorders and LWH. Varma et al. did not find higher adjusted risks of depression associated with increased number of hours in senior medical consultants, even when they worked for more than 60 hours per week.^{[46][49]} Depression or mood disorders measured with GHQ-12, SCLDS or BDI, all validated tools for mental health, were not associated with increased number of working hours ^{[39][42]} nor improved after decreasing the number of hours from 90-110 to 78-80 hours per week in residents.^[4447]

Field Code Changed

Field Code Changed

General health: Four studies of intermediate quality analysed the association between LWH and general health. Zahrai et al. found that increased number of hours spent by residents in hospital correlated significantly with poorer general health, physical function and vitality using SF-36.^{[47][50]} A comparative study of physicians in two different countries found that Norwegians showed higher non-adjusted prevalence of self-reported good health compared to physicians in Germany who worked longer hours.^{[43][46]} An increased adjusted risk of impaired general health was found for men and women general practitioners who worked for more than 47 hours per week.^{[45][48]} However, following the implementation of reducing the number of hours from an average of 90-110hours/week to 78-80hours/week did not lead to an overall improvement of residents self-reported physical health.^[4447]

Field Code Changed

Field Code Changed

Synthesis of the evidence:

The levels of evidence synthesis obtained from the analysis of the 11 studies included in this review are shown in table 4.

Table 4. Available scientific evidence on the health problems associated with long working hours in physicians: levels of evidence synthesis.

Health outcome	Degree of evidence*	Magnitude of the association**	Studies ID
Percutaneous injuries	++	++	Ayas 2006[37] , Fisman 2007[40] , Ayas 2006[40] , Fisman 2007[43]
MMotor Motor vehicle accidents	++	++	Barger 2005[38] , Kirkealdy 1997[42] , Barger 2005[41] , Kirkealdy 1997[45]
Mood disorders	+	+/-	Varma 2012[46] , Hayasaka 2007[41] , Firth Cozens 2001[39] , Zahrai 2011[47] , Stamp 2005[44] , Sundquist 2000[45] , Varma 2012[49] , Hayasaka 2007[44] , Firth Cozens 2001[42] , Zahrai 2011[50] , Stamp 2005[47] , Sundquist 2000[48]
General health	+	+/-	Zahrai 2011[47] , Stamp 2005[44] , Sundquist 2000[45] , Rosta 2011[43] , Zahrai 2011[50] , Stamp 2005[47] , Sundquist 2000[48] , Rosta 2011[46]

Formatted: Indent: Hanging: 0.1"

* Strong evidence (+++): consistent results in more than 2 studies of high quality; Moderate evidence (++) : consistent results in two studies of high quality, or one high quality study and one intermediate, or between some studies of intermediate quality; Insufficient evidence (+): identification of only one

study or inconsistent results across studies; Evidence of no association (-): consistent results of a non-association in two or more studies.

** Magnitude of the association: it refers to the magnitude of the association point estimate (RR = relative risk, rate ratio or odds ratio): high (+++) if $RR > 3$; intermediate (++) if $RR = 1.5-3$; low (+) if $RR < 1.5$; no association (-); unclear (+/-).

There is moderate evidence of an association between LWH and percutaneous and motor vehicle accidents in physicians. This evidence comes from one study of high quality and another of intermediate quality both for percutaneous injuries, and for motor vehicle accidents and the magnitude of this association could be intermediate.

For mood disorders and general health there is a low or insufficient level of evidence of an association with LWH in physicians. This comes from 6 studies on mood disorders and 4 on general health of high and intermediate methodological quality and inconsistent results among them. No conclusion can be drawn about the magnitude of such associations if existed.

DISCUSSION

This review found moderate scientific evidence for a positive association of intermediate magnitude between exposure to LWH and percutaneous injuries and motor vehicle accidents in physicians. Evidence was assessed as low or insufficient for mood disorders and general health.

To our knowledge, this is the first systematic review on the effects of LWH on physicians' health and safety. The extensive searches were restricted to indexed journals. We systematically identified, selected and assessed the methodological quality of studies by means of independent pairs of reviewers. The quality assessment form and the levels of evidence used in this review were based on CONSORT and STROBE statements and on previous systematic reviews.^{[33, 35, 36][36, 38, 39]} To give some estimate of the potential magnitude of the effect, we added levels based on the point estimates of measures of association provided by the studies. However, such levels had not been previously established.

Strengths and limitations of the studies

1
2
3
4
5
6 Four studies had a longitudinal prospective design, however only two of them used a
7 robust methodology. Two other studies used a crossover design, which reduces the
8 likelihood of individual variability and confounding, and were considered well
9 designed. Four studies, all rated as intermediate methodological quality, were cross
10 sectional in design and therefore it is difficult to draw causal relationships from them.
11 Although reverse causality cannot be ruled out from cross-sectional designs, it is
12 unlikely that poorer health determines longer working hours than their healthier peers.

13
14
15
16 One study used a quasi-experimental design but lacked a control group. Also, because
17 of different designs used across the included studies, different estimates of the effects
18 were used that may not be directly comparable.
19

20
21 Other limitations include the variability, validity and reliability of working hours, which
22 in most studies was self-reported. Although only those papers specifying the number of
23 working hours were accepted, shift and night work might have worked as confounders
24 too, as it is difficult to acknowledge which proportion of the health effects observed was
25 due exclusively to the LWH component and not due, for instance, to stress, fatigue or
26 sleep deprivation. Moreover, the studies did not discriminate between time spent
27 actively working or asleep while on call, though the EWTD considers all hours on call
28 as working time. Likewise, it is possible that participants were aware that the study was
29 conducted to assess associations between the number of hours worked and health
30 outcomes. Therefore, there might be a volunteer bias in those doctors who work
31 extended hours. To minimise this bias, a case-cross over analysis has been performed in
32 three of the included study [40, 41, 43].
33
34
35
36
37
38

Formatted: Font: (Intl) Arial Unicode MS

39
40 Health outcomes were measured mainly based upon self-report, with the exception of
41 documented motor vehicle crashes, [37][40] reported percutaneous injuries [39][42] and
42 register-notified anti-depressive drug prescriptions. [45] ~~No studies with other objective~~
43 ~~measures of health (e.g.,~~ [48] ~~No studies with other objective measures of health (e.g.,~~
44 mortality) or mental disease (e.g., hospital data) were identified. However, self-reported
45 or perceived health was assessed by validated and widely used instruments, especially
46 when health status (general, mental or physical health) or ill-health symptoms are
47 evaluated. Nonetheless, this raises the possibility that the observed associations might
48 reflect differences in propensity to report health problems when they occur rather than
49 true differences in the risk of worse health status. We cannot rule this out, but the higher
50 propensity for reporting among those who work for longer hours and poorer work
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

schedule patterns would have to relate specifically to the reporting of ill-health rather than non-ill health. It seems unlikely that major differences in propensity to report would extend to a more concrete outcome.

The majority of the studies of this review took into account confounding variables in their analyses, such as sex and age. However, none of the studies analysed the potential effect of modifying factors, such as psychosocial aspects at work, including attitudes, motivation, job requirements, demands and content, organisational climate, social relationships at work, work satisfaction, supportive organisation, or the relative number of physicians and other staff available for patient care. Neither were important aspects outside of work, such as life events or lifestyles, taken into account. The study of Japanese female physicians found significant differences by marital status with higher GHQ scores for those who were married.^[4144] There are significant differences in the number of physicians per capita across different countries and this together with the structure and organisation of health services are potential confounders too that were not addressed in the selected studies across countries.

A relevant outcome from this review would be to establish a threshold number of extended hours above which there is a significantly higher risk. There is a lack of evidence for a dose-response relationship and nor does the evidence give any indication for a threshold number of hours that physicians could work and remain safe and healthy.

Finally, the heterogeneity of the included studies did not allow a more quantitative synthesis, and a level of evidence approach was used instead.

Comparison with other studies

Our findings of an association between LWH and injuries and accidents in physicians are consistent with research in other occupational groups. Dembe et al. carried out a longitudinal survey in the US including more than 10,000 workers from a variety of occupations and settings.^{[46][19]} A strong dose-response effect (adjusted for age, gender, occupation, industry and region) was found between LWH and injuries above 40h/week and 8h/day; jobs with overtime schedules were associated with a 61% higher injury hazard rate compared to jobs without overtime; working at least 12 hours per day was associated with a 37% increased hazard rate, and working at least 60 hours per week was associated with a 23% increased hazard rate. They concluded that LWH

22

Field Code Changed

Field Code Changed

1
2
3
4
5
6 might indirectly precipitate workplace injuries through a causal process by inducing
7 fatigue or stress in workers. In a separate study assessing injury risks to health care
8 personnel, Dembe et al. demonstrated that the risk of injury when working overtime or
9 at least 60 h per week among physicians and nurses was statistically significant.[51] In
10 our review we found that information about the length of shift work varied across
11 studies, some analysing shifts of up to twenty four hours. Work that included such shifts
12 was more strongly associated with accidents and injuries.[3740, 3841]

Field Code Changed

13 We found insufficient evidence of an association between LWH and mood disorders,
14 other diseases and general health in physicians, despite some scientific evidence
15 suggesting that LWH increase morbidity and mortality in other occupations.[16-2319-
16 26]

Field Code Changed

17 Possible explanations for these inconsistencies might be the scarcity of high quality
18 research, and the fact that some of the included papers did not fully address the effect of
19 confounding factors, and the possibility that working as a physician might have a
20 protective effect by itself, for instance through higher motivation and social recognition
21 relative to other occupations.

22 Stamp et al., in the only before and after study, did not find significant differences for
23 mood disorder or general health before and after implementing requirements to reduce
24 working schedules to 80h/week in residents.[44][47] It is debatable, however, whether
25 any conclusions can be drawn from the impact of reducing extremely high working
26 hours (90-110hours/week) to very high working hours (78-80hours/week).

27 ~~Although we searched for and identified literature describing associations between~~
28 ~~LWH and increased mortality in doctors,[48, 49] none of those studies specified the~~
29 ~~number of hours worked, and therefore were not included.~~

30 Although we searched for and identified literature describing associations between
31 LWH and increased mortality in doctors,[52, 53] none of those studies specified the
32 number of hours worked, and therefore were not included.

33 **Recommendations for future research**

34 Further research, including well designed prospective and retrospective longitudinal
35 studies, is needed in this field to establish on scientific grounds what number of hours
36
37
38
39

1
2
3
4
5
6 are safe, both to patients and physicians. Also studies on long term health effects should
7 be considered.
8

9
10 This review was aimed to study exclusively possible detrimental health effects of LWH
11 (more than 48 hours per week) to physicians. Other systematic reviews should be
12 conducted addressing issues, such as the impact of working hours on doctor's well-
13 being and quality of life, the quality of junior doctors training, the quality and continuity
14 of care and impact on patient safety. Also, from a staffing perspective, the economic
15 and social burden of sick leave and physicians leaving the profession are important
16 issues that were beyond the scope of this review and that should be considered in future
17 research. ~~Other established criteria [50]~~Other established criteria [54] that working
18 hours should be 'family friendly', promote gender equality, enhance productivity or
19 facilitate worker choice and influence over working hours, were not addressed. Further
20 research is needed in these other areas.
21
22
23
24
25
26
27

28 **Conclusions**

29
30 The findings of this review have confirmed that long working hours are associated with
31 both an increased risk of needlestick injuries and road traffic accidents. The fact that
32 these associations are labelled moderate in this review, should not preclude safety
33 procedures and measures being assessed and reassessed to ensure maximum physician
34 and patient safety. The reduction of needlestick injuries requires improved use of safe
35 sharp devices, compliance with safe working procedures, training and regular audits of
36 working practices, particularly for junior doctors who are at greatest risk of needlestick
37 injuries, possibly due to inadequate training.^[51, 52][55, 56] The risk of road traffic
38 accidents could be reduced by discouraging driving after very long shifts (more than 16
39 hours) and where there is sleep deprivation.^[53][57] Transport should be provided by
40 the employer in these situations. This is a pragmatic recommendation which recognises
41 that long working hours have not been eliminated as a result of the EWTD.
42
43
44
45
46
47

48 This review uncovered the lack of literature on the effect of long working hours on the
49 general health of doctors, a topic that has important health ramifications not only for
50 physicians but for patients too. However, the paucity of available studies, which does
51 not allow for a causal or dose-response relationship to be established, raises further
52 questions about the evidence-base of the current 48 hour limit, especially as this is not
53
54
55
56
57
58
59
60

1
2
3
4
5
6 | enforced strictly and junior doctors, for example in the UK, may opt-out.^{[54][58]} It may
7 | be relevant that the EWTD was not based entirely on science but also took into account,
8 |
9 | as does all EU legislation, the views of "social partners".^{[3][3]}
10

11 | It is likely that the mechanism for these increased health and safety risks is fatigue, and
12 | our finding of increased risk of accidents to staff, may also be associated with increased
13 | risk of clinical errors. Patient safety was not the purpose of this review but long working
14 | hours are well recognised to cause decrement in performance both in health care and
15 | other professions, where the performance of staff can be safety critical, such as airline
16 | pilots, and professional drivers.^{[55][59]}
17 |
18 |
19 |

20 | In addition the EWTD has been associated with real concerns about the adequacy of the
21 | training of doctors given their reduced exposure to patient care, and the lack of
22 | experience of the patient journey, imposed by adherence to the EWTD.^{[4][4]} This is
23 | potentially exacerbated at the same time by the constraints on the overall duration of
24 | training imposed by other EU directives.^{[56][60]} Further reviews of the EWTD, with
25 | regard to this unique group of workers, need to take into account other social factors
26 | such as the impact on patient care. This is particularly the case when all health care
27 | systems are under strain because of burgeoning demands and limited resources.^{[4][4]}
28 |
29 |
30 |
31 |

32
33
34 | The findings of this systematic review lead to the suggestion of the following guidelines
35 | in the event of non-compliance with the EWTD: 1) long shifts should be avoided to
36 | protect both physicians' health and patient safety and no shift should be longer than 16
37 | hours (and then exceptionally);^[28] 2) Physicians should be discouraged from driving
38 | after long shifts to reduce the risk of motor accidents;^[41, 45] 3) rigorous attention
39 | should be paid to reducing the risk of sharps injuries;^[40, 43] 4) organisational aspects
40 | such as workload and job control, as well as the pattern and distribution of working
41 | hours, breaks and recovery periods should be carefully taken into account, in order to
42 | avoid fatigue and sleep deprivation that could lead to mistakes and accidents;^[61, 62] 5)
43 | Physicians should work in supportive psychosocial environments, in teams, and with
44 | adequate training and supervision as their wellbeing is important also for the health of
45 | their patients.^[61, 62]
46 |
47 |
48 |
49 |
50 |

51
52 | Further research is required to establish any longer term effects such as on mortality and
53 | mental health, also the impact of the nature of the work organisation taking into account
54 |

Field Code Changed

Field Code Changed

1
2
3
4
5
6 the psychosocial aspects of the physicians working and non-working lives, and to
7 determine how many hours are safe for physicians to work.
8
9

10 11 **ACKNOWLEDGMENTS**

12 Leena Isotalo, Trial Search Coordinator at the Cochrane Occupational Safety and
13 Health Review Group, designed and conducted the final search of the evidence using
14 Medline and Embase databases.
15
16

17 18 19 **CONFLICT OF INTERESTS**

20 None. No financial relationships with any organisations that might have an interest in
21 the submitted work, and no other relationships or activities that could appear to have
22 influenced the submitted work.
23
24

25 26 27 **FUNDING**

28 The Section of Occupational Medicine of the UEMS provided limited support to the
29 work of all authors (MCR, ED, SVP, KS, AS, PR, RH), with the exception of the senior
30 authors (EBM, CS). The expenses of one meeting of the core group (MCR, ED, SVP,
31 EBM, CS) were also funded by the Section. **Role of funding source:** The Section of
32 Occupational Medicine of the UEMS acted in its role of promoting and contributing to
33 the research in Occupational Medicine.
34
35
36
37
38

39 40 **AUTHORS' CONTRIBUTIONS:**

41 Mari Cruz Rodríguez-Jareño, Evangelia Demou, Sergio Vargas-Prada, Alenka Škerjanc,
42 Kaveh A Sanati, Ewan B. Macdonald and Consol Serra conceived and submitted the
43 design, carried out the acquisition of data, analysis and interpretation of data, drafted the
44 article and revised it.
45
46

47 Pedro G. Reis and Ritva Helimäki-Aro contributed to acquisition of data, analysis and
48 interpretation of data, drafted the article and revised it.
49

50 All authors gave final approval of the version to be published, and agree to be
51 accountable for all aspects of the work.
52
53
54
55

1
2
3
4
5
6 **ETHICS COMMITTEE APPROVAL** was not sought as no patients were involved in
7 this study.
8
9

11 REFERENCES

- 12 1 EUR-Lex. Directive 2003/88/EC of the European Parliament and of the Council of 4
13 November 2003 concerning certain aspects of the organisation of working time. In:
14 Union OJotE, ed. Brussels: Official Journal of the European Union, 2003.
15
- 16 2 EPHA. 2012 EPHA Briefing on the European Working Time Directive (EWTd)
17 http://www.eph.org/IMG/pdf/EPHA_Briefing_EWTD_Oct2012_FINAL.pdf;
18 Access Year 2012.
19
- 20 3 European Commission. 2013 Working Conditions-Working Time Directive.
21 <http://ec.europa.eu/social/main.jsp?catId=706&langId=en&intPageId=205>; Access
22 Date December 2013.
23
- 24 4 House J. Calling time on doctors' working hours. *Lancet* 2009;**373**:2011-12.
25
- 26 5 The Lancet. Doctors' training and the European Working Time Directive. *Lancet*
27 2010;**375**:2121.
28
- 29 6 Leff D, Aziz O, Darzi A. Trucks, planes, and scalpels - Is there an evidence-based
30 approach to surgeons' working hours? *Arch Surg* 2007;**142**:817-20.
31
- 32 7 Parthasarathy S. Sleep and the medical profession. *Curr Opin Pulm Med* 2005;**11**:507-
33 12.
34
- 35 8 Dr. Foster Hospital Guide. 2011 www.drfoosterhealth.co.uk; Access Date February
36 2011.
37
- 38 9 UEMS. 2012 The Union of European Medical Specialists. www.uems.net; Access
39 Year 2012.
40
- 41 10 Macdonald EB, Ritchie KA, Murray KJ, Gilmour WH. Requirements for
42 occupational medicine training in Europe: a Delphi study. *Occup Environ Med*
43 2000;**57**:98-105.
44
- 45 11 Macdonald E, Baransky B, Wilford J. Occupational Medicine in Europe: Scope and
46 Competencies. In: Health WECfEa, ed. Health, Environment and Safety in Enterprises
47 Series n. 3. Bilthoven, The Netherlands, 2000.
48
- 49 12 Ballester M, Cordell N, Rodriguez Jareno MC, Serra C, Med USO. A European
50 survey of professional bodies representing occupational medicine specialists. *Occup
51 Med (Oxf)* 2012;**62**:366-70.
52
- 53 13 Cashman C, Slovak A. The occupational medicine agenda: Routes and standards of
54 specialization in occupational medicine in Europe. *Occup Med (Oxf)* 2005;**55**:308-
55 11.
56
57
58
59
60

1
2
3
4
5
6 14 De Schryver A, Claesen B, Meheus A, van Sprundel M, Francois G. European
7 survey of hepatitis B vaccination policies for healthcare workers. *Eur J Public Health*
8 2011;**21**:338-43.
9

10 ~~45~~15 Rodriguez-Juareno M, Serra C, Demou E, et al. European Working Time
11 Directive: systematic review for evidence based decision making. SUMMARY
12 REPORT. In: Medicine USoO, ed. [http://www.uems-](http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf)
13 [occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-](http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf)
14 [%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf](http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf); UEMS Section of
15 Occupational Medicine, 2011.
16

17 16 UEMS. 2010 The Newsletter of European Medical Specialists.
18 [http://www.uems.eu/ data/assets/pdf file/0014/1463/1466.pdf](http://www.uems.eu/data/assets/pdf_file/0014/1463/1466.pdf).
19

20 17 UEMS. Meetings of the Board & Council of UEMS- Report. In: European Union of
21 Medical Specialists;
22 [http://www.uems.eu/ data/assets/pdf file/0011/1235/UEMS_2011.37 - report -](http://www.uems.eu/data/assets/pdf_file/0011/1235/UEMS_2011.37_-_report_-_UEMS_Council_6-8.10.2010_Napoli.pdf)
23 [UEMS Council 6-8.10.2010 Napoli.pdf](http://www.uems.eu/data/assets/pdf_file/0011/1235/UEMS_2011.37_-_report_-_UEMS_Council_6-8.10.2010_Napoli.pdf), ed. Napoli (Italy), 2011.
24

25 18 Bannai A, Tamakoshi A. The association between long working hours and health: A
26 systematic review of epidemiological evidence. *Scand J Work Environ Health* 2013.
27

28 ~~46~~19 Dembe AE, Erickson JB, Delbos RG, Banks SM. The impact of overtime and long
29 work hours on occupational injuries and illnesses: new evidence from the United
30 States. *Occup Environ Med* 2005;**62**:588-97.
31

32 ~~47~~20 Johnson JV, Lipscomb J. Long working hours, occupational health and the
33 changing nature of work organization. *Am J Ind Med* 2006;**49**:921-9.
34

35 ~~48~~21 Kivimaeki M, Batty GD, Hamer M, et al. Using Additional Information on
36 Working Hours to Predict Coronary Heart Disease. *Ann Intern Med* 2011;**154**.
37

38 ~~49~~22 Liu Y, Tanaka H, Fukuoka Heart Study G. Overtime work, insufficient sleep, and
39 risk of non-fatal acute myocardial infarction in Japanese men. *Occup Environ Med*
40 2002;**59**:447-51.
41

42 ~~20~~23 Sokejima S, Kagamimori S. Working hours as a risk factor for acute myocardial
43 infarction in Japan: case-control study. *BMJ* 1998;**317**:775-80.
44

45 ~~21~~24 Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated
46 with long working hours: A review of the current position. *Occup Environ Med*
47 1997;**54**:367-75.
48

49 ~~22~~25 Virtanen M, Ferrie JE, Singh-Manoux A, et al. Long working hours and
50 symptoms of anxiety and depression: a 5-year follow-up of the Whitehall II study.
51 *Psychol Med* 2011;**41**:2485-94.
52

53 ~~23~~26 Virtanen M, Stansfeld SA, Fuhrer R, Ferrie JE, Kivimaki M. Overtime work as a
54 predictor of major depressive episode: a 5-year follow-up of the Whitehall II study.
55 *PloS One* 2012;**7**:e30719.
56
57
58
59
60

- 1
2
3
4
5
6 | [2427](#) Gopal R, Glasheen JJ, Miyoshi TJ, Prochazka AV. Burnout and internal medicine
7 resident work-hour restrictions. *Arch Intern Med* 2005;**165**:2595-600.
8
9 | [2528](#) Reed DA, Fletcher KE, Arora VM. Systematic Review: Association of Shift
10 Length, Protected Sleep Time, and Night Float With Patient Care, Residents' Health,
11 and Education. *Ann Intern Med* 2010;**153**:829-42.
12
13 | [2629](#) Sargent MC, Sotile W, Sotile MO, Rubash H, Barrack RL. Quality of Life During
14 Orthopedic Training and Academic Practice Part 1: Orthopedic Surgery Residents
15 and Faculty. *J Bone Joint Surg Am* 2009;**91A**:2395-405.
16
17 | [2730](#) Fletcher KE, Underwood W, Davis SQ, Mangrulkar RS, McMahon LF, Saint S.
18 Effects of work hour reduction on residents' lives - A systematic review. *JAMA*
19 2005;**294**:1088-100.
20
21 | [2831](#) Black C, Frost D. *Health at work - an independent review on sickness absence*.
22 London: The Stationary Office, 2011.
23
24 | [2932](#) Waddell G, Burton K. *Is work good for your health and wellbeing?* London: The
25 Stationary Office, 2006.
26
27 | [3033](#) Butterworth P, Leach LS, Strazdins L, Olesen SC, Rodgers B, Broom DH. The
28 psychosocial quality of work determines whether employment has benefits for
29 mental health: results from a longitudinal national household panel survey. *Occup*
30 *Environ Med* 2011;**68**:806-12.
31
32 | [3134](#) Lockley SW, Landrigan CP, Barger LK, Czeisler CA. When policy meets
33 physiology - The challenge of reducing resident work hours. *Clin Orthop* 2006:116-
34 27.
35
36 | [3235](#) ICD-10. 2012 International Classification of Diseases.
37 <http://www.who.int/classifications/icd/en/>; Access Year 2012.
38
39 | [3336](#) van Uffelen JGZ, Wong J, Chau JY, et al. Occupational Sitting and Health Risks
40 A Systematic Review. *Am J Prev Med* 2010;**39**:379-88.
41
42 | [3437](#) Kirsling RA, Kochar MS, Chan CH. An evaluation of mood states among 1st-year
43 residents. *Psychol Rep* 1989;**65**:355-66.
44
45 | [3538](#) Bernard B. A critical review of epidemiologic evidence for work-related
46 musculoskeletal disorders of the neck, upper extremity and low back. In: NIOSH, ed.
47 Publication No. 9741. Cincinnati: National Institute for Occupational Safety and
48 Health, 1997.
49
50 | [3639](#) Steenstra IA, Verbeek JH, Heymans MW, Bongers PM. Prognostic factors for
51 duration of sick leave in patients sick listed with acute low back pain: a systematic
52 review of the literature. *Occup Environ Med* 2005;**62**:851-60.
53
54 | [3740](#) Ayas NT, Barger LK, Cade BE, et al. Extended work duration and the risk of self-
55 reported percutaneous injuries in interns. *JAMA* 2006;**296**:1055-62.
56
57
58
59
60

- 1
2
3
4
5
6 | [3841](#) Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor
7 vehicle crashes among interns. *N Engl J Med* 2005;**352**:125-34.
8
9 | [3942](#) Firth-Cozens J. Emotional Distress in Junior House Officers. *BMJ* 1987;**295**:533-
10 36.
11
12 | [4043](#) Fisman DN, Harris AD, Rubin M, Sorock GS, Mittleman MA. Fatigue increases
13 the risk of injury from sharp devices in medical trainees: Results from a case-
14 crossover study. *Infect Control HospEpidemiology* 2007;**28**:10-17.
15
16 | [4144](#) Hayasaka Y, Nakamura K, Yamamoto M, Sasaki S. Work environment and
17 mental health status assessed by the general health questionnaire in female Japanese
18 doctors. *Ind Health* 2007;**45**:781-86.
19
20 | [4245](#) Kirkcaldy BD, Trimpop R, Cooper CL. Working hours, job stress, work
21 satisfaction, and accident rates among medical practitioners and allied personnel. *Int*
22 *J Stress Manag* 1997;**4**:79-87.
23
24 | [4346](#) Rosta J, Aasland OG. Work Hours and Self rated Health of Hospital Doctors in
25 Norway and Germany. A comparative study on national samples. *BMC Health Serv*
26 *Res* 2011;**11**.
27
28 | [4447](#) Stamp T, Termuhlen P, Miller S, et al. Before and after resident work hour
29 limitations: an objective assessment of the well-being of surgical residents. *Curr Surg*
30 2005;**62**:117-21.
31
32 | [4548](#) Sundquist J, Johansson SE. High demand, low control, and impaired general
33 health: working conditions in a sample of Swedish general practitioners. *Scand J Pub*
34 *Health* 2000;**28**:123-31.
35
36 | [4649](#) Varma A, Marott J, Stoltenberg C, Wieclaw J, Kolstad H, Bonde J. With long
37 hours of work, might depression then lurk? A nationwide prospective follow-up
38 study among Danish senior medical consultants. *Scand J Work Environ Health*
39 2012;**38**:418-26.
40
41 | [4750](#) Zahrai A, Chahal J, Stojimirovic D, Schemitsch EH, Yee A, Kraemer W. Quality
42 of life and educational benefit among orthopedic surgery residents: a prospective,
43 multicentre comparison of the night float and the standard call systems. *Can J Surg*
44 2011;**54**:25-32.
45
46 | [4851 Dembe AE, Delbos R, Erickson JB. Estimates of injury risks for healthcare](#)
47 [personnel working night shifts and long hours. *Quality & Safety in Health Care*](#)
48 [2009;**18**:336-40.](#)
49
50 | [52](#) Lindfors PM, Nurmi KE, Meretoja OA, et al. On-call stress among Finnish
51 anaesthetists. *Anaesthesia* 2006;**61**:859-64.
52
53 | [4953](#) Šelb J, Albreht T. Mortality rates of medical doctors in Slovenia in 1985 to 1999.
54 *Zdravniški vestnik* 2000:147-148.
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- | [5054](#) Lee S, McCann D, Messenger J. Working Time Around the World: Trends in working hours, laws and policies in a global comparative perspective. Geneva, Switzerland: International Labour Office, 2007.
- | [5155](#) Elder A, Paterson C. Sharps injuries in UK health care: a review of injury rates, viral transmission and potential efficacy of safety devices. *Occup Med-Oxford* 2006;**56**:566-74.
- | [5256](#) Naghavi SHR, Sanati KA. Needlestick injuries: Does left-handedness matter? *Am J Infect Control* 2009;**37**:341-41.
- | [5357](#) Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury to car occupants: population based case control study. *BMJ* 2002;**324**:1125-28A.
- | [5458](#) BMA. 2013 European Working Time Directive, <http://bma.org.uk/practical-support-at-work/ewtd>. Access Date December 2013.
- | [5559](#) Wilson AM, Weston G. Application of Airline Pilots Hours to Junior Doctors. *BMJ* 1989;**299**:779-81.
- | [5660](#) The European Specialist Medical Qualifications Order 1995. 1995 Statutory Instruments, 1995 No. 3208, MEDICAL PROFESSION, The European Specialist Medical Qualifications Order 1995, <http://legislation.data.gov.uk/ukxi/1995/3208/made/data.htm?wrap=true>. Access Date December 2013.
- | [5761](#) Boorman S. NHS Health and Well-being. The Boorman Review. Leeds, 2009.
- | [5862](#) Williams S, Michie S, Pattani S. Improving the health of the NHS workforce. Report of the partnership on the health of the NHS Workforce. London: The Nuffield Trust, 1998.

Formatted: EndNote Bibliography, Indent: Left: 0", Hanging: 0.19", Space Before: 0 pt, After: 0 pt, Line spacing: single

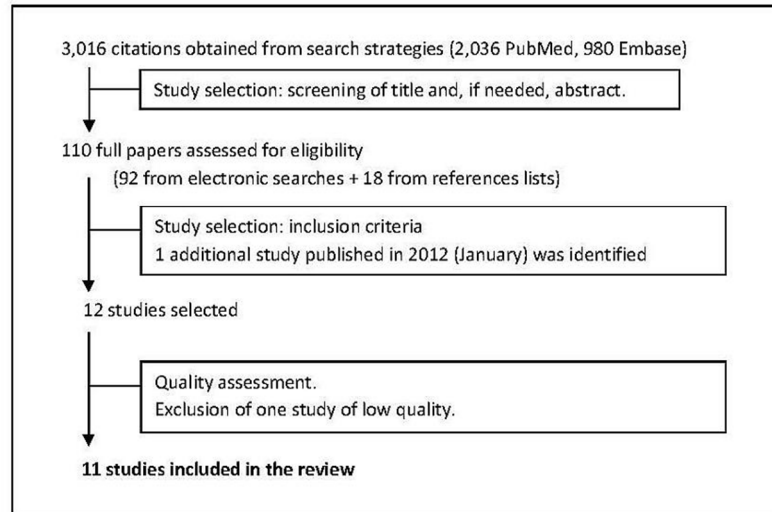


Figure 1. Results of the search strategy, using search engines on PubMed and EMBASE (December 2011) and screening of references lists of identified full papers, study selection and quality assessment.
90x59mm (300 x 300 DPI)



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8-9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8-9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8-9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2 for each meta-analysis).	8-9



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10-11
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	12-13
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	18
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-19
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	19
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	21-23
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	24-25

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

BMJ Open

European Working Time Directive and doctors' health. A Systematic review of the available epidemiological evidence.

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2014-004916.R2
Article Type:	Research
Date Submitted by the Author:	12-Jun-2014
Complete List of Authors:	Rodriguez-Jareno, Maria-Cruz; Universitat de Girona, 2. Department of Medical Sciences Demou, Evangelia; University of Glasgow, Institute of Health and Wellbeing Vargas, Sergio; Universitat Pompeu Fabra, Centre for Research in Occupational Health Sanati, Kaveh; University of Glasgow, Institute of Health and Wellbeing Skerjanc, Alenka; University Medical Centre, 6. Clinical Institute of Occupational, Traffic and Sports Medicine Reis, Pedro; 7. College of Occupational Medicine, Portuguese Medical Association Helimaki-Aro, Ritva; 8. Helsinki City Occupational Health Centre, Macdonald, Ewan; University of Glasgow, Institute of Health and Wellbeing Serra, Consol; Universitat Pompeu Fabra, Centre for Research in Occupational Health
Primary Subject Heading:	Health policy
Secondary Subject Heading:	Medical management, Research methods, Health services research, Health policy, Evidence based practice
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

1
2
3 **European Working Time Directive and doctors' health. A Systematic review of the**
4 **available epidemiological evidence.**
5
6

7 **Running title:** Long working hours and doctors' health
8
9

10
11
12 ***Corresponding author**
13

14 Dr. Evangelia Demou
15 Healthy Working Lives Group
16 Institute of Health and Wellbeing
17 University of Glasgow
18 Glasgow, G12 8RZ
19 Tel: +44 141 330 3559
20 E-mail: evangelia.demou@glasgow.ac.uk
21
22

23 Maria Cruz Rodriguez-Jareño^{1,2}, Evangelia Demou^{3,*}, Sergio Vargas-Prada⁴, Kaveh A
24 Sanati^{3,5}, Alenka Škerjanc⁶, Pedro G. Reis⁷, Ritva Helimäki-Aro⁸, Ewan B.
25 Macdonald³, Consol Serra^{1,4,9,10}, on behalf of the UEMS Section of Occupational
26 Medicine¹¹.
27
28
29
30
31

- 32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
1. Catalan and Spanish Societies of Occupational Medicine, Barcelona, Spain.
 2. Department of Medical Sciences. School of Medicine. Universitat de Girona. Girona. Spain
 3. Institute of Health and Wellbeing, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, United Kingdom
 4. CiSAL - Centre for Research in Occupational Health, Universitat Pompeu Fabra, Barcelona, Spain.
 5. Occupational Health Department, Epsom & St Helier University Hospitals NHS Trust, Surrey, United Kingdom
 6. Clinical Institute of Occupational, Traffic and Sports Medicine, University Medical Centre, Ljubljana, Slovenia.
 7. College of Occupational Medicine, Portuguese Medical Association, Lisbon, Portugal.
 8. Helsinki City Occupational Health Centre, Helsinki, Finland.
 9. Occupational Health Service, Parc de Salut MAR, Barcelona, Spain.
 10. CIBER of Epidemiology and Public Health. Spain.
 11. UEMS Section of Occupational Medicine. <http://www.uems-occupationalmedicine.org>

55 Word Count: 4,794
56
57
58
59
60

ABSTRACT

Objective: To summarise the available scientific evidence on the health effects of exposure to working beyond the limit number of hours established by the European Working Time Directive (EWTD) on physicians.

Design: A systematic literature search was conducted in PubMed and Embase. Study selection, quality appraisal and data extraction were carried out by independent pairs of researchers using pre-established criteria.

Setting: Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Participants: The total number of participants was 14,338.

Primary and secondary outcome measures: Health effects classified under the International Classification of Diseases (ICD-10).

Results: Over 3,000 citations and 110 full articles were reviewed. From these, eleven studies of high or intermediate quality carried out in North America, Europe and Japan met the inclusion criteria. Six studies included medical residents, junior doctors or house officers and the five others included medical specialists or consultants, medical, dental and general practitioners and hospital physicians. Evidence of an association was found between percutaneous injuries and road traffic accidents with extended hours/day or very long working weeks (LWH). The evidence was insufficient for mood disorders and general health. No studies on other health outcomes were identified.

Conclusions: LWH could increase the risk of percutaneous injuries and road traffic accidents, and possibly other incidents at work through the same pathway. While associations are clear, the existing evidence does not allow for an established causal or "dose-response" relationship between LWH and incidents at work, or for a threshold number of extended hours above which there is a significantly higher risk and the hours physicians could work and remain safe and healthy. Policy makers should consider safety issues when working on relaxing EWTD for doctors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The first systematic review, to our knowledge, on the effects of Long Working Hours (LWH) on physicians' health and safety.
- A systematic literature search conducted in PubMed and Embase with over 3,000 citations and 110 full articles reviewed.
- Eleven studies of high or intermediate quality carried out in North America, Europe and Japan, involving physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.
- The findings of this review confirmed that long working hours are associated with both an increased risk of needlestick injuries and road traffic accidents. Evidence was assessed as low or insufficient for mood disorders and general health.
- This review uncovered the lack of literature on the effect of long working hours on the general health of doctors, a topic that has important health ramifications not only for physicians but for patients too.

KEY WORDS: Working time, "Physicians"[MeSH], "Morbidity"[MeSH], "Occupational Injuries"[MeSH], Systematic review.

INTRODUCTION

The European Working Time Directive (EWTD),[1] applicable to all occupations across the EU, requires a maximum working week of 48 hours and establishes rest periods.[2, 3] Since it came into force in healthcare in 2009, it has been associated with concerns about the provision of health services including continuity of care, lower staffing levels, introduction of shift working, a reduction in training time and the adequate supervision of junior doctors.[4, 5] The large inter-country variations in physicians working hours as well as the mandatory controls over work hours across occupations raises further questions as to the basis of selecting and setting these limits and restrictions.[6] There is evidence of variable compliance to the EWTD within health care across Europe.[4, 5] The medical profession is also increasingly feminised with potential implications for women of childbearing age, which may coincide with the time in the profession where long working hours (LWH) are more likely to happen (i.e. during residency). Constraint on public-sector finances and increasing health care demands, have stimulated the debate on physicians' working hours,[7] with some evidence showing that the quality of health care is positively correlated with the number of physicians available to deliver that care.[8]

The Union of European Medical Specialists (UEMS) was created in 1958 to represent medical specialists in the EU, promote a high standard of training and practice at European level and facilitate the free movement of physicians across European countries.[9] The Occupational Medicine section was created in 1997 and is involved in issues related to specialist training, professional practice and research;[10] elaborating and publishing reference documents,[11] conducting and contributing to surveys,[12-14] and working in partnership with other key European groups.

The trigger for this project was a request by the Council of the UEMS to its Occupational Medicine Section for a position statement on the EWTD and possible health consequences to physicians of a potential removal of this professional group from the current EWTD 48 hours per week limit.[15-17] An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.[15]

LWH have been associated with several adverse effects on workers' health, such as hypertension, cardiovascular disease, stress, depression, musculoskeletal disorders, chronic infections, diabetes, general health complaints and all-cause mortality in a variety of occupational groups.[18-26] In physicians, there is some evidence suggesting

1
2
3 that LWH can result in impacts such as stress, depression, burnout, injuries, fatigue and
4 sleep deprivation,[27-29] and overwork has been considered one of the most stressful
5 features of physicians' work.[27] Some evidence exists of the beneficial effect of
6 reducing the number of working hours on the quality of life of medical residents [30]
7 and on burnout.[27]
8
9

10
11 However, the relationship between work and health is complex. There is a substantial
12 body of evidence showing that worklessness is associated with poorer health, whereas
13 work is generally good for health and well-being,[31, 32] provided that the work
14 environment is reasonably acceptable and supportive.[33]
15
16
17

18 Occupational and non-occupational exposures may play an important role such as the
19 pattern and distribution of working hours, breaks, and recovery periods. Also,
20 psychosocial and organisational factors, such as workload, job control, managers and
21 peer support, training opportunities, individual characteristics and attitudes may be
22 important.[6, 34]
23
24
25
26

27 Finally, physicians are a highly qualified, devoted and motivated professional group.
28 Despite other existing reviews of a more general occupational approach, a review
29 focused on physicians is warranted.
30
31
32

33 The aim of this project was to systematically review whether long-working hours
34 (LWH) -i.e. defined as more than the 48 hour per week limit imposed by the EWTD-
35 are associated with health effects –i.e. classified under the International Classification of
36 Diseases (ICD-10) [35]- in physicians, and to examine what these associations are. This
37 review does not include the potential impact of LWH on patient care or physician
38 training.
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

METHODS

The systematic review sought to respond to the following research question: are LWH associated with health effects in physicians? For the purpose of this review, exposure to LWH was defined as working for more than 48 hours per week.[1] Health outcomes included any disease as defined in the ICD-10 [35] and work related injuries. If self-assessed tools on health status were used, only those validated were considered. Burnout, stress and outcomes such as individual symptoms, signs or biological markers (blood pressure, ECG, etc.) were not considered. Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Study identification

Electronic searches were carried out using PubMed and EMBASE as search engines (December 2011). Our search strategy was similar in both databases and consisted of a combination of the following keywords and Mesh terms: night shift, morning shift, evening shift, afternoon shift, shift work, rotating shift, shift combination, shift duration or length, shift system, clockwise rotation, shift roster, extended shifts, night work, evening work, work schedule, work hours, starting time, early start, irregular working hours, direction of rotation, overwork, extended hours, shift rota, workload, work schedule tolerance, sleep deprivation, sleep disorders, chronobiology disorders, circadian rhythm, psychomotor performance, circadian disruption, vigilance, alertness, wakefulness, drowsiness, fatigue, insomnia, hypersomnolence, dyssomnia, eveningness, morningness, neurocognitive performance, concentration difficulties, arousal, health, morbidity, mortality, disease, illness, stress, strain, distress, accident, injur*, death, suicid*, education, medical, physician, medical staff, hospital, doctor, surgeon, house officers, medical school, surgery, surgical.

In addition, the references lists of articles selected for inclusion were carefully reviewed to identify additional studies.

Study selection

1
2
3 Studies were included if they measured the association between the exposure to LWH
4 and health effects in physicians, used an observational epidemiological (i.e. cohort,
5 case-control, cross-sectional) or experimental design. Articles relating to on-call, night
6 or shift work, but with unknown exposure or exposed to less than 48 working hours per
7 week were excluded. They were also excluded if the working groups were other than
8 physicians or addressed only other exposures or outcomes (i.e. patient safety, fatigue,
9 sleep deprivation, social or family disruption). No limitation was set for languages.

10
11 A total of 2,036 citations were obtained from PubMed and 980 non-duplicated citations
12 using Embase, yielding a total of 3,016 citations that were all screened by independent
13 pairs of reviewers. All titles and, where necessary, abstracts were reviewed. Ninety two
14 potentially suitable publications were identified from the electronic searches, and 18
15 further studies were identified from the references lists, yielding a total of 110 studies
16 published in English, French, German, Italian, Slovenian and Spanish. For all of them
17 the full text was obtained and reviewed by independent pairs of reviewers.
18 Disagreements within pairs were resolved by discussion and, where necessary, by a
19 third reviewer who made the final decision. All authors participated as reviewers for
20 screening the citations and full papers using well defined and pre-established criteria.
21 Ninety nine articles were excluded at this stage. One further study was identified that
22 was published after the search period. Finally, 12 papers were considered for quality
23 assessment (Figure 1).

24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
The methodological quality of the 12 studies was assessed by independent pairs of
reviewers. A standardized 16 point scale based on CONSORT and STROBE statements
and adapted from a previous systematic review [36] was used. It includes 16 items
grouped into 6 areas: 1) objectives, 2) study design, 3) target population and sample, 4)
variables, 5) data sources, collection and measurement, and 6) statistical methods. Each
item was rated as 1 (the requirement was met), 0.5 (the requirement was partially met)
or 0 (the requirement was not or unclearly met). Disagreements within pairs of
reviewers were resolved by consensus or, where necessary, by a third reviewer. For
each of the 12 studies, a final score based on the sum of all items was assigned and the
percentage was calculated based on a maximum score of 16. Study quality was rated as
low, moderate or high if it scored less than 60%, between 60% and 79.9%, and 80% or
more of the maximum score, respectively.

1
2
3 One article of low quality was excluded [37] and a total of 11 studies of intermediate or
4 high methodological quality were included for the purpose of this review (figure 1).
5
6
7

8 9 **Data extraction**

10 Selected information was extracted from each paper, including publication year, country
11 of origin, study design, setting, study population, sample size, response rate, measure of
12 working hours, definition used for LWH, health outcomes and their measurement, and
13 main results on point risk estimates or frequencies of health outcomes, and their
14 corresponding 95% confidence interval (95%CI), and whether the analyses were
15 adjusted for potential confounders.
16
17
18
19
20
21

22 23 24 **Evidence synthesis**

25 To summarise the results on the relationship between LWH and health effects, levels of
26 evidence synthesis was performed. This was based on the methodological quality, study
27 design and the consistency of the study outcomes. The following criteria were based on
28 two previous relevant systematic reviews.[38, 39]
29
30
31

32 Strong evidence: consistent results in more than two studies of high quality.
33
34

35 Moderate evidence: consistent results in one high quality study and one intermediate, or
36 between some studies of intermediate quality.
37
38

39 Insufficient evidence: identification of only one study or inconsistent results across
40 studies;
41

42 Evidence of no association: consistent results of a non-association in two or more
43 studies.
44
45

46 A measure of the possible magnitude of the association was attempted using the
47 following criteria based on the association point estimate (RR = relative risk, rate ratio
48 or odds ratio) when available or otherwise the comparison between two frequencies was
49 used:
50
51

- 52 • high: $RR > 3.00$
- 53 • intermediate: $RR = 1.50-3.00$
- 54 • low: $RR = 1.01-1.49$
- 55 • no association: $RR=1.00$
- 56
- 57
- 58
- 59
- 60

- unclear

RESULTS

We identified 11 studies related to LWH and health effects in physicians that were eligible for inclusion. The outcome of the methodological quality assessment is given in table 1.

Methodological quality was appraised as high for 3 of the 11 studies, with scores ranging from 84 to 94%. The other 8 studies were considered as intermediate quality as their scores ranged from 63 to 78%. The majority of all included studies received positive scores on items describing the study objectives, design and the study population (items from areas 1, 2 and 3), as well as the description of exposure and outcome variables (item 4). However, although data sources and collection were well described, reliability and validity of exposure to LWH and health outcome measures had low scores (items 5b and 5c). The statistical methods were in general appropriate, however the confounding variables were not measured in several studies and, as can be seen, the studies did not describe how they addressed missing data (items 6a and 6b).

Study characteristics:

The characteristics of the included studies are described in table 2.

Table 1. Methodological quality appraisal of the included studies

Study ID		Ayas 2006 [40]	Barger 2005 [41]	Firth- Cozens 1987 [42]	Fisman 2007 [43]	Hayasaka 2007 [44]	Kirkcaldy 1997 [45]	Rosta 2011 [46]	Stamp 2005 [47]	Sundquist 2000 [48]	Varma 2012 [49]	Zahrai 2011 [50]
1	Objectives	Are the objectives or hypotheses of the research described in the paper?	1	1	1	1	1	1	1	1	1	1
2	Study design	Is the study design presented?	1	1	1	1	1	1	1	1	1	1
3a	Target population	Do the authors describe the target population they wanted to research?	1	1	1	1	1	1	1	1	1	1
3b	Sample	Was a random sample of the target population taken? AND was the response rate 60% or more?	0.5	0.5	1	0.5	0.5	0.5	1	1	1	0.5
3c	Sample	Is participant selection described?	1	1	1	1	0.5	1	0	1	1	1
3d	Sample	Is participant recruitment described, or referred to?	1	1	1	1	1	1	1	1	1	0
3e	Sample	Are the inclusion and/or exclusion criteria stated?	1	1	1	1	0.5	0.5	1	1	1	0.5
3f	Sample	Is the study sample described? (minimum description: sample size, gender, age and occupation)	1	1	0	1	1	1	0	0	0	1
3g	Sample	Is the number of participants at each stage of the study reported?	1	1	1	0.5	1	0.5	1	1	1	1
4	Variables	Are the measures of long working hours and the health outcome described?	1	1	0.5	1	1	1	1	1	1	1
5a	Data sources, collection	Do authors describe the source of their data (e.g., official registry, health survey) AND how the data were collected?	1	1	1	1	1	1	1	1	1	1
5b	Measurement	Was reliability of the measure(s) of long working hours mentioned or referred to?	0	0	0	1	0	0	0	1	0	0
5c	Measurement	Was the validity of the measure(s) of long working hours mentioned or referred to?	1	1	0	0	0	0	0	0	0	0
5d	Measurement	Were health outcomes assessed by objective measures or validated self-reporting instruments?	0	1	1	1	1	0	1	1	1	1

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

6a	Statistical methods	Were appropriate statistical methods used and described, including those for addressing confounders?	0.5	1	0.5	1	0.5	0.5	1	0.5	1	1	0.5
6b	Statistical methods	Were the numbers/% of participants with missing data for long working hours and the health outcome indicated AND If more than 20% of data in the primary analyses were missing, were methods used to address missing data?	0	0	0	0.5	0	0	0	0	0	1	0.5
Total score** (%)			12.0 (75)	13.5 (84)	11.0 (69)	13.5 (84)	11.0 (69)	10.0 (63)	10.5 (66)	12.5 (78)	12.0 (75)	15.0 (94)	11.0 (69)
Quality rate***			interm	high	interm	high	interm	interm	interm	interm	interm	high	interm

** Maximum score = 16; *** Quality rate (%): low=<60; intermediate (interm)=60-79; high=80-100.

Peer review only

Table 2. Characteristics of the included studies.

Study ID	Country Of Study Population	Design*	Setting	Participants and sample size (response rate)	Working hours	Health outcomes	Quality score (%)
Ayas 2006 [40]	United States	Cohort, prospective (1 year) / Case-crossover	Hospital	Interns in postgraduate residency programs Sample size: 2,737 (80%)	Mean (SD) hrs worked/month: 249.8 (75.3). Self-reported, monthly survey. Strong correlation (Pearson $r=0.76$; $p < 0.001$) with hours worked 244 (69.3) from work diaries of randomly selected subset of 192 interns. Extended periods (20 or more consecutive hours) vs. non extended periods (12 hrs or less consecutive hours).	Self-reported percutaneous injuries	12.0 (75)
Barger 2005 [41]	United States	Cohort, prospective (1 year)	Hospital	Residents first postgraduate year (interns). Sample size: 2,737 (80%)	Mean (SD) hrs worked/week 70.7 (26.0). Extended shift (≥ 24 hrs) vs. non extended shift (< 24 hours). Self-reported, validated.	Self-reported and documented motor vehicle crashes.	13.5 (84)
Firth Cozens 1987 [42]	United Kingdom	Cohort, prospective (1 year)	Hospital	Junior house officers Sample size: 170 (72%)	Mean number of hours per week = 90.6 hours (include on call). Self-reported.	GHQ-12 (case: score ≥ 2) and SCLDS, self-reported	11.0 (69)
Fisman 2007 [43]	United States and Canada	Case-Crossover	Hospital	Medical trainees vs. other HCW. Sample size: 109 vs. 241 (46%)	Median number of hours per week: medical trainees = 70; other HCW = 40 ($p < 0.001$). Self-reported, high reliability.	Reported percutaneous injuries to employee health care service.	13.5 (84)
Hayasaka 2007 [44]	Japan	Cross-sectional	Hospital, clinics, other	Female physicians Sample size: 367 (63%)	Comparison of increasing number of hrs/week from ≤ 30 to > 50 , self-reported.	GHQ-30 (case: score ≥ 8), self-reported	11.0 (69)
Kirkcaldy 1997 [45]	Germany	Cross-sectional	Not specified	Medical and dental practitioners. Sample size: 2,500 (not specified)	Long hours: mean 58.36 hrs/week SD 9.16 Short hours: mean 38.17 hrs/week SD 7.72 Self-reported.	Self-reported traffic accidents	10.0 (63)
Rosta 2011 [46]	Germany and Norway	Cross-sectional	Hospital	Hospital physicians Participants: 1,917 (58%) in Germany and 1,072 (65%) in Norway answered the questionnaire. From survey responders, 1,260 (65.7%) Germans and 562 (52.4) Norwegians were included in the analysis after applying further inclusion criteria.	German vs. Norwegian physicians (%): Hours per day > 9 = 58.8 vs. 26.7 60 hours on-call per month = 63.4 vs. 18.3 Self-reported.	Validated questionnaire on self-rated health	10.5 (66)
Stamp 2005 [47]	United States	Before-and-after	Hospital	Residents of general surgery Sample size: 28 (97%)	Changes of work patterns, after reduction from 90-110 to 78-80 work hrs/week.	SF-36, mental health; BDI, depression; self-reported	12.5 (78)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Sundquist 2000 [48]	Sweden	Cross-sectional	Primary care	General practitioners Sample size: 1,004 (72%)	Overtime defined as working at least 47 hrs/week. Self-reported.	Swedish SF-36, impaired mental health, self-reported	12.0 (75)
Varma 2012 [49]	Denmark	Cohort, prospective (20 months)	Hospital	Senior medical consultants Sample size: 2,790 (62%)	Long work hours (>40hrs/week). Self-reported.	Depression: redemption of anti-depressive drug prescriptions	15.0 (94)
Zahrai 2011 [50]	Canada	Cohort, prospective (6 months)	Hospital	Orthopaedic surgery residents Sample size: 16 (not specified)	Night float (n=9): 77.8% did >80h/week at baseline; 71.4% at follow-up. Standard call (n=7): 57.1% did >80h week at baseline; 80% at follow-up.	SF-36, mental health score, self-reported	11.0 (69)

* Follow-up period in brackets for prospective cohort studies; GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Five had been carried out in North America (4 in the United States [40, 41, 43, 47] and 1 in Canada [50]), five in European countries (Denmark,[49] Germany,[45] Norway and Germany [43]; Sweden,[48] and the United Kingdom [42]) and one study in Japan.[44] Four used a prospective cohort design (follow-up ranging from 6 to 20 months), 2 were case-crossover, 4 cross-sectional, and 1 was a before and after study. Overall, the total number of participants was 14,338 and included medical residents, junior doctors or house officers only working in hospitals, medical specialists or consultants, medical and dental practitioners, general practitioners, hospital physicians and one study included female physicians from a community service. Most studies (n=9) compared different working hour patterns within the same group of physicians, one compared physicians from two different countries,[46] and one included other health care workers as the comparison group.[43]

LWH was defined as more than 48hours/week in most studies, and some did not provide a definition. Two studies considered LWH below 48/week.[46, 48] All the included studies investigated health effects associated with working more than 48h/week, with number of hours ranging between <30 to 110hours/week. One paper studied the effects of an increasing number of hours from 30 to more than 50h/week.[44] Others studied more than 40h/week,[49] 47h/week,[48] above 58h/week [46](two studies) and 6 studies referred to more than 70h/week,[40-43, 47, 50] one of which compared 78-80h/week to 90-110 weekly hours.[47] Information on working hours was self-reported in nine studies, with reasonably good validity only in two studies [40, 41] and reliability in one.[43] In the other two studies it was obtained from established work schedules.[47, 50]

Identified health outcomes that fulfilled the inclusion criteria were percutaneous injuries, motor vehicle accidents, mood disorders and general health. Information was self-reported in all studies using well known validated questionnaires, except three studies that used documented information on motor vehicle crashes,[40] reported percutaneous injuries [42] and antidepressant prescription data as a surrogate of depression.[49]

Summary of findings:

Table 3 shows the findings from each of the 11 studies.

Table 3. Results on the association between long working hours and identified health effects in physicians.

Health outcome	Main results	Adjustment by confounders	Study ID
Percutaneous injuries	Odds ratio (95% CI) for injuries during extended (>20 hours/day) vs. non extended periods (first 12 hours at work): All percutaneous injuries: 1.61 (1.46-1.78); Injuries reported to OH: 1.83 (1.48-2.28); Injuries in the ICU: 1.87 (0.69-5.04); Injuries in the operating room or labour and delivery: 1.77 (1.49-2.09); Injuries in the ICU, non-ICU, or ED: 2.17 (1.56-3.00)	Time of day and circadian influences	Ayas 2006[40]
Percutaneous injuries	Medical trainees vs. other health care workers: total median working hours: 70 vs. 40 hours (p<.001); median previous working hours at the time of injury: 6.5 vs. 5 hours (p<.001). Odds ratio (95% CI) for self-reported fatigue: work > 40h in the past week: 3.50 (2.06-5.92); work during more than 5d in past week: 4.20 (4.46-7.15); >12h at work before injury: 8.58 (3.7-19.86). Incidence rate ratio (95%CI) for association between fatigue and injuries: all workers: 1.40 (1.03-1.90); medical trainees: 2.94 (1.71-5.07); other HCWs: 0.97 (0.66-1.42) (p=0.001 for heterogeneity).	Age and sex	Fisman 2007[43]
Motor vehicle accidents	Odds ratios (95% CI), after extended shift (≥ 24hrs) vs. non extended shift (<24 hours): Crashes = 2.3 (1.6-3.3); Near miss accidents = 5.9 (5.4-6.3)	Age and sex	Barger 2005[41]
Motor vehicle accidents	Incidence rates of driving accidents on house visits: Long hours (mean 58.36 hrs/week) = 0.10 (0.31) vs. short hours (mean 38.17 hrs/week) = 0.02 (0.18). p<0.05	Not adjusted	Kirkcaldy 1997[45]
Mood disorders, depression	Hazard ratio (95% CI) hours/week intervals and redemption of anti-depressive drug prescription(reference group: 37-40 h/week): 25-36 h: 0.83 (0.24-2.82); 41-44 h: 0.95 (0.50-1.77); 45-49 h: 0.88 (0.43-1.78); 50-54 h: 0.83 (0.32-2.14); 55-59 h: 0.67 (0.15-2.94); >60 h: 0.48 (0.06-3.68). Cox regression analysis of work hours as a continuous variable: HR=0.93 (0.76-1.13)	Age, sex, marital status, medical specialty, decision authority at work, social support at work, quantitative work demands and previous redemption of AD drug prescription	Varma 2012[49]
Mood disorders, GHQ-30	Prevalence of cases by working time (hours/week) < 30 hours: 35.7% (41/115); >30 to 40 hours: 39.0% (39/100); >40 to 50 hours: 37.7% (26/69); >50 hours: 56.8% (46/81); p=0.0179 Stepwise multiple logistic regression, >50 h/wk. vs. ≤50 h/wk.: parameter 0.635 (p=0.0293)	Marital status, medical facility, position, and night duty.	Hayasaka 2007[44]
Mood disorders, GHQ-12 and SCLDS	No association was found between number of hours worked in a week and depression.	Not adjusted	Firth Cozens 1987[42]
Mood disorders, SF-36	Scores when night float vs. standard call at baseline and follow-up: Mental health mean score (SD): baseline = 57.33 (22.63) vs. 65.71 (7.61); follow up = 52.00 (15.49) vs. 60.80 (11.45); p=0.72 Mental health component summary (SD), baseline = 34.84 (14.06) vs. 40.21 (7.61); follow up = 30.15 (10.71) vs. 42.40 (6.23); p=0.39 Regression analysis: increased number of hours in hospital correlated with significantly lower SF-36 scores in almost all domains.	Not adjusted	Zahrai 2011[50]
Mood disorders, SF-36 and BDI	Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week): Mental health SF-36): no statistically significant improvement Individual questions BDI before and after duty hours limitations, only energy level statistically significant.	Not adjusted	Stamp 2005[47]

Health outcome	Main results	Adjustment by confounders	Study ID
Mood disorders, SF-36	Odds ratio (95% CI) for working 47 hours per week or more: Impaired mental health, men: 1.59 (0.95-2.66); women: 1.86 (1.03-3.37)	Age and amount of time in practice	Sundquist 2000 [48]
General health, SF-36	SF-36: Scores when night float vs. standard call at baseline and follow-up: General health mean score (SD): baseline = 62.11 (17.47) vs. 77.57 (24.25); follow up = 56.43 (24.89) vs. 84.20 (16.50); p=0.41 Physical health component summary (SD): baseline = 46.16 (13.15) vs. 52.01 (13.33); follow up = 39.32 (9.80) vs. 56.15 (2.18); p=0.015 Vitality mean score (SD): baseline = 51.67 (14.58) vs. 51.43 (15.74); follow up = 48.57 (14.92) vs. 51.00 (10.84); p=0.20 Regression analysis demonstrated that the increased number of hours spent in hospital correlated with significantly lower general health, physical function, mental health, role emotional, social function and mental component summary scale scores (all p < 0.05)	Not adjusted	Zahrai 2011 [50]
General health, SF-36	SF-36, BDI: Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week: Physical health: no statistically significant differences.	Not adjusted	Stamp 2005 [47]
General health, SF-36	SF-36: Odds ratio (95% CI) adjusted for age and time in practice, for working 47 hours per week or more: Impaired general health: men = 1.66 (1.00-2.77); women = 1.59 (1.00-3.17)	Age and amount of time in practice	Sundquist 2000 [48]
General health	Self-rated health: Odds ratio (95% CI) of good self-rated health (logistic regression): Norwegian work time pattern**= 1.35 (1.03-1.77); working in Norway = 4.17 (3.02 - 5.73).	Age, sex and country of work	Rosta 2011 [46]

**Not working more than 9 hours a day and having more than 60 hours a month on-call); GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3 *Percutaneous injuries:* One study of high quality and one of intermediate quality, with
4 non-adjusted analyses, showed consistent results in medical trainees. Ayas et al. found
5 an increased risk of percutaneous injuries associated with working more than 20
6 hours/day compared to non-extended hour periods, except in intensive care units;[40]
7 Fisman et al. found an association between self-reported fatigue and the number of
8 working hours at the time of injury and a 3-fold increased risk of sharp injuries in
9 medical trainees compared to other health care workers (median of working hours/week
10 before the injury: 70 vs. 40;p<.001).[43]

11
12
13
14
15
16
17 *Motor vehicle accidents:* Two studies of high and intermediate quality showed that long
18 working weeks were associated with an at least two-fold increased risk. Barger et al.
19 found adjusted increased risks for car crashes (OR 2.3; 95%CI 1.6-3.3) and near miss
20 accidents (OR 5.9; 95%CI 5.4-6.3) associated with working extended shifts.[41]
21 Kirkcaldy et al. showed that non-adjusted incidence rates of traffic accidents on house
22 visits was five times as much when physicians worked for a mean of 58 hours/week
23 compared to 38 hours/week (p<0.05).[45]

24
25
26
27
28
29 *Mood disorders:* Six studies of intermediate and high quality found contradictory
30 results for mood disorders. Three of them, all of intermediate quality, provided evidence
31 of an association between LWH and mental health problems. The prevalence of GHQ-
32 30 cases was higher for female physicians working above 50 hours/week than for those
33 working 30 or less hours/week (p<0.05).[44] and an increased adjusted risk of impaired
34 mental health was found for men and women general practitioners who worked for 47
35 hours per week or more.[48] Zahrai et al. found that increased number of hours spent by
36 residents in hospital correlated significantly with lower mental health and mental
37 component summary scale scores (SF-36).[50] Three other studies, one of which of
38 high quality, did not find an association between depression or mood disorders and
39 LWH. Varma et al. did not find higher adjusted risks of depression associated with
40 increased number of hours in senior medical consultants, even when they worked for
41 more than 60 hours per week.[49] Depression or mood disorders measured with GHQ-
42 12, SCLDS or BDI, all validated tools for mental health, were not associated with
43 increased number of working hours [42] nor improved after decreasing the number of
44 hours from 90-110 to 78-80 hours per week in residents.[47]

45
46
47
48
49
50
51
52
53
54
55
56 *General health:* Four studies of intermediate quality analysed the association between
57 LWH and general health. Zahrai et al. found that increased number of hours spent by
58
59
60

residents in hospital correlated significantly with poorer general health, physical function and vitality using SF-36.[50] A comparative study of physicians in two different countries found that Norwegians showed higher non-adjusted prevalence of self-reported good health compared to physicians in Germany who worked longer hours.[46] An increased adjusted risk of impaired general health was found for men and women general practitioners who worked for more than 47 hours per week.[48] However, following the implementation of reducing the number of hours from an average of 90-110hours/week to 78-80hours/week did not lead to an overall improvement of residents self-reported physical health.[47]

Synthesis of the evidence:

The levels of evidence synthesis obtained from the analysis of the 11 studies included in this review are shown in table 4.

Table 4. Available scientific evidence on the health problems associated with long working hours in physicians: levels of evidence synthesis.

Health outcome	Degree of evidence*	Magnitude of the association**	Studies ID
Percutaneous injuries	++	++	Ayas 2006[40], Fisman 2007[43]
Motor vehicle accidents	++	++	Barger 2005[41], Kirkcaldy 1997[45]
Mood disorders	+	+/-	Varma 2012[49], Hayasaka 2007[44], Firth Cozens 2001[42], Zahrai 2011[50], Stamp 2005[47], Sundquist 2000[48]
General health	+	+/-	Zahrai 2011[50], Stamp 2005[47], Sundquist 2000[48], Rosta 2011[46]

* Strong evidence (+++): consistent results in more than 2 studies of high quality; Moderate evidence (++) : consistent results in two studies of high quality, or one high quality study and one intermediate, or between some studies of intermediate quality; Insufficient evidence (+): identification of only one study or inconsistent results across studies; Evidence of no association (-): consistent results of a non-association in two or more studies.

** Magnitude of the association: it refers to the magnitude of the association point estimate (RR = relative risk, rate ratio or odds ratio): high (+++) if RR > 3; intermediate (++) if RR = 1.5-3; low (+) if RR < 1.5; no association (-); unclear (+/-).

1
2
3 There is moderate evidence of an association between LWH and percutaneous and
4 motor vehicle accidents in physicians. This evidence comes from one study of high
5 quality and another of intermediate quality both for percutaneous injuries, and for motor
6 vehicle accidents and the magnitude of this association could be intermediate.
7
8

9
10 For mood disorders and general health there is a low or insufficient level of evidence of
11 an association with LWH in physicians. This comes from 6 studies on mood disorders
12 and 4 on general health of high and intermediate methodological quality and
13 inconsistent results among them. No conclusion can be drawn about the magnitude of
14 such associations if existed.
15
16
17
18
19

20 21 **DISCUSSION**

22
23 This review found moderate scientific evidence for a positive association of
24 intermediate magnitude between exposure to LWH and percutaneous injuries and motor
25 vehicle accidents in physicians. Evidence was assessed as low or insufficient for mood
26 disorders and general health.
27
28
29

30
31 To our knowledge, this is the first systematic review on the effects of LWH on
32 physicians' health and safety. The extensive searches were restricted to indexed
33 journals. We systematically identified, selected and assessed the methodological quality
34 of studies by means of independent pairs of reviewers. The quality assessment form and
35 the levels of evidence used in this review were based on CONSORT and STROBE
36 statements and on previous systematic reviews.[36, 38, 39] To give some estimate of
37 the potential magnitude of the effect, we added levels based on the point estimates of
38 measures of association provided by the studies. However, such levels had not been
39 previously established.
40
41
42
43
44
45
46
47

48 **Strengths and limitations of the studies**

49
50 Four studies had a longitudinal prospective design, however only two of them used a
51 robust methodology. Two other studies used a crossover design, which reduces the
52 likelihood of individual variability and confounding, and were considered well
53 designed. Four studies, all rated as intermediate methodological quality, were cross
54 sectional in design and therefore it is difficult to draw causal relationships from them.
55
56
57
58
59
60

1
2
3 Although reverse causality cannot be ruled out from cross-sectional designs, it is
4 unlikely that poorer health determines longer working hours than their healthier peers.
5 One study used a quasi-experimental design but lacked a control group. Also, because
6 of different designs used across the included studies, different estimates of the effects
7 were used that may not be directly comparable.
8
9

10
11 Other limitations include the variability, validity and reliability of working hours, which
12 in most studies was self-reported. Although only those papers specifying the number of
13 working hours were accepted, shift and night work might have worked as confounders
14 too, as it is difficult to acknowledge which proportion of the health effects observed was
15 due exclusively to the LWH component and not due, for instance, to stress, fatigue or
16 sleep deprivation. Moreover, the studies did not discriminate between time spent
17 actively working or asleep while on call, though the EWTD considers all hours on call
18 as working time. Likewise, it is possible that participants were aware that the study was
19 conducted to assess associations between the number of hours worked and health
20 outcomes. Therefore, there might be a volunteer bias in those doctors who work
21 extended hours. To minimise this bias, a case-cross over analysis has been performed in
22 three of the included study [40, 41, 43].
23
24

25 Health outcomes were measured mainly based upon self-report, with the exception of
26 documented motor vehicle crashes,[40] reported percutaneous injuries [42] and register-
27 notified anti-depressive drug prescriptions.[48] No studies with other objective
28 measures of health (e.g., mortality) or mental disease (e.g., hospital data) were
29 identified. However, self-reported or perceived health was assessed by validated and
30 widely used instruments, especially when health status (general, mental or physical
31 health) or ill-health symptoms are evaluated. Nonetheless, this raises the possibility that
32 the observed associations might reflect differences in propensity to report health
33 problems when they occur rather than true differences in the risk of worse health status.
34 We cannot rule this out, but the higher propensity for reporting among those who work
35 for longer hours and poorer work schedule patterns would have to relate specifically to
36 the reporting of ill-health rather than non-ill health. It seems unlikely that major
37 differences in propensity to report would extend to a more concrete outcome.
38
39

40 The majority of the studies of this review took into account confounding variables in
41 their analyses, such as sex and age. However, none of the studies analysed the potential
42 effect of modifying factors, such as psychosocial aspects at work, including attitudes,
43
44
45
46
47
48
49
50
51
52
53

1
2
3 motivation, job requirements, demands and content, organisational climate, social
4 relationships at work, work satisfaction, supportive organisation, or the relative number
5 of physicians and other staff available for patient care. Neither were important aspects
6 outside of work, such as life events or lifestyles, taken into account. The study of
7 Japanese female physicians found significant differences by marital status with higher
8 GHQ scores for those who were married.[44] There are significant differences in the
9 number of physicians per capita across different countries and this together with the
10 structure and organisation of health services are potential confounders too that were not
11 addressed in the selected studies across countries.
12
13
14
15
16
17
18

19 A relevant outcome from this review would be to establish a threshold number of
20 extended hours above which there is a significantly higher risk. There is a lack of
21 evidence for a dose-response relationship and nor does the evidence give any indication
22 for a threshold number of hours that physicians could work and remain safe and healthy.
23
24

25 Finally, the heterogeneity of the included studies did not allow a more quantitative
26 synthesis, and a level of evidence approach was used instead.
27
28
29
30
31

32 **Comparison with other studies**

33
34 Our findings of an association between LWH and injuries and accidents in physicians
35 are consistent with research in other occupational groups. Dembe et al. carried out a
36 longitudinal survey in the US including more than 10,000 workers from a variety of
37 occupations and settings.[19] A strong dose-response effect (adjusted for age, gender,
38 occupation, industry and region) was found between LWH and injuries above 40h/week
39 and 8h/day; jobs with overtime schedules were associated with a 61% higher injury
40 hazard rate compared to jobs without overtime; working at least 12 hours per day was
41 associated with a 37% increased hazard rate, and working at least 60 hours per week
42 was associated with a 23% increased hazard rate. They concluded that LWH might
43 indirectly precipitate workplace injuries through a causal process by inducing fatigue or
44 stress in workers. In a separate study assessing injury risks to health care personnel,
45 Dembe et al. demonstrated that the risk of injury when working overtime or at least 60 h
46 per week among physicians and nurses was statistically significant.[51] In our review
47 we found that information about the length of shift work varied across studies, some
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 analysing shifts of up to twenty four hours. Work that included such shifts was more
4 strongly associated with accidents and injuries.[40, 41]
5

6
7 We found insufficient evidence of an association between LWH and mood disorders,
8 other diseases and general health in physicians, despite some scientific evidence
9 suggesting that LWH increase morbidity and mortality in other occupations.[19-26]
10

11
12 Possible explanations for these inconsistencies might be the scarcity of high quality
13 research, and the fact that some of the included papers did not fully address the effect of
14 confounding factors, and the possibility that working as a physician might have a
15 protective effect by itself, for instance through higher motivation and social recognition
16 relative to other occupations.
17

18
19 Stamp et al., in the only before and after study, did not find significant differences for
20 mood disorder or general health before and after implementing requirements to reduce
21 working schedules to 80h/week in residents.[47] It is debatable, however, whether any
22 conclusions can be drawn from the impact of reducing extremely high working hours
23 (90-110hours/week) to very high working hours (78-80hours/week).
24
25

26
27 Although we searched for and identified literature describing associations between
28 LWH and increased mortality in doctors,[52, 53] none of those studies specified the
29 number of hours worked, and therefore were not included.
30
31

32 **Recommendations for future research**

33
34 Further research, including well designed prospective and retrospective longitudinal
35 studies, is needed in this field to establish on scientific grounds what number of hours
36 are safe, both to patients and physicians. Also studies on long term health effects should
37 be considered.
38

39
40 This review was aimed to study exclusively possible detrimental health effects of LWH
41 (more than 48 hours per week) to physicians. Other systematic reviews should be
42 conducted addressing issues, such as the impact of working hours on doctor's well-
43 being and quality of life, the quality of junior doctors training, the quality and continuity
44 of care and impact on patient safety. Also, from a staffing perspective, the economic
45 and social burden of sick leave and physicians leaving the profession are important
46 issues that were beyond the scope of this review and that should be considered in future
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 research. Other established criteria [54] that working hours should be 'family friendly',
4 promote gender equality, enhance productivity or facilitate worker choice and influence
5 over working hours, were not addressed. Further research is needed in these other areas.
6
7

8 9 **Conclusions**

10
11 The findings of this review have confirmed that long working hours are associated with
12 both an increased risk of needlestick injuries and road traffic accidents. The fact that
13 these associations are labelled moderate in this review, should not preclude safety
14 procedures and measures being assessed and reassessed to ensure maximum physician
15 and patient safety. The reduction of needlestick injuries requires improved use of safe
16 sharp devices, compliance with safe working procedures, training and regular audits of
17 working practices, particularly for junior doctors who are at greatest risk of needlestick
18 injuries, possibly due to inadequate training.[55, 56] The risk of road traffic accidents
19 could be reduced by discouraging driving after very long shifts (more than 16 hours)
20 and where there is sleep deprivation.[57] Transport should be provided by the employer
21 in these situations. This is a pragmatic recommendation which recognises that long
22 working hours have not been eliminated as a result of the EWTD.
23
24
25
26
27
28
29
30

31
32 This review uncovered the lack of literature on the effect of long working hours on the
33 general health of doctors, a topic that has important health ramifications not only for
34 physicians but for patients too. However, the paucity of available studies, which does
35 not allow for a causal or dose-response relationship to be established, raises further
36 questions about the evidence-base of the current 48 hour limit, especially as this is not
37 enforced strictly and junior doctors, for example in the UK, may opt-out.[58] It may be
38 relevant that the EWTD was not based entirely on science but also took into account, as
39 does all EU legislation, the views of "social partners".[3]
40
41
42
43
44

45
46 It is likely that the mechanism for these increased health and safety risks is fatigue, and
47 our finding of increased risk of accidents to staff, may also be associated with increased
48 risk of clinical errors. Patient safety was not the purpose of this review but long working
49 hours are well recognised to cause decrement in performance both in health care and
50 other professions, where the performance of staff can be safety critical, such as airline
51 pilots, and professional drivers.[59]
52
53
54

55
56 In addition the EWTD has been associated with real concerns about the adequacy of the
57 training of doctors given their reduced exposure to patient care, and the lack of
58
59
60

1
2
3 experience of the patient journey, imposed by adherence to the EWTD.[4] This is
4 potentially exacerbated at the same time by the constraints on the overall duration of
5 training imposed by other EU directives.[60] Further reviews of the EWTD, with regard
6 to this unique group of workers, need to take into account other social factors such as
7 the impact on patient care. This is particularly the case when all health care systems are
8 under strain because of burgeoning demands and limited resources.[4]
9
10
11
12

13
14
15 The findings of this systematic review lead to the suggestion of the following guidelines
16 in the event of non-compliance with the EWTD: 1) long shifts should be avoided to
17 protect both physicians' health and patient safety and no shift should be longer than 16
18 hours (and then exceptionally);[28] 2) Physicians should be discouraged from driving
19 after long shifts to reduce the risk of motor accidents;[41, 45] 3) rigorous attention
20 should be paid to reducing the risk of sharps injuries;[40, 43] 4) organisational aspects
21 such as workload and job control, as well as the pattern and distribution of working
22 hours, breaks and recovery periods should be carefully taken into account, in order to
23 avoid fatigue and sleep deprivation that could lead to mistakes and accidents;[61, 62] 5)
24 Physicians should work in supportive psychosocial environments, in teams, and with
25 adequate training and supervision as their wellbeing is important also for the health of
26 their patients.[61, 62]
27
28
29
30
31
32
33
34
35

36 Further research is required to establish any longer term effects such as on mortality and
37 mental health, also the impact of the nature of the work organisation taking into account
38 the psychosocial aspects of the physicians working and non-working lives, and to
39 determine how many hours are safe for physicians to work.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

ACKNOWLEDGMENTS

Leena Isotalo, Trial Search Coordinator at the Cochrane Occupational Safety and Health Review Group, designed and conducted the final search of the evidence using Medline and Embase databases.

FUNDING

The Section of Occupational Medicine of the UEMS provided limited support to the work of all authors (MCR, ED, SVP, KS, AS, PR, RH), with the exception of the senior authors (EBM, CS). The expenses of one meeting of the core group (MCR, SVP, ED, EBM, CS) were also funded by the Section. **Role of funding source:** The Section of Occupational Medicine of the UEMS acted in its role of promoting and contributing to the research in Occupational Medicine.

AUTHORS' CONTRIBUTIONS:

Mari Cruz Rodríguez-Jareño, Evangelia Demou, Sergio Vargas-Prada, Alenka Škerjanc, Kaveh A Sanati, Ewan B. Macdonald and Consol Serra conceived and submitted the design, carried out the acquisition of data, analysis and interpretation of data, drafted the article and revised it.

Pedro G. Reis and Ritva Helimäki-Aro contributed to acquisition of data, analysis and interpretation of data, drafted the article and revised it.

All authors gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

CONFLICT OF INTERESTS

None. No financial relationships with any organisations that might have an interest in the submitted work, and no other relationships or activities that could appear to have influenced the submitted work.

DATA SHARING STATEMENT

No additional data are available

ETHICS COMMITTEE APPROVAL was not sought as no patients were involved in this study.

REFERENCES

- 1 EUR-Lex. Directive 2003/88/EC of the European Parliament and of the Council of 4 November 2003 concerning certain aspects of the organisation of working time. In: Union OJotE, ed. Brussels: Official Journal of the European Union, 2003.
- 2 EPHA. 2012 EPHA Briefing on the European Working Time Directive (EWTD) http://www.ephpa.org/IMG/pdf/EPHA_Briefing_EWTD_Oct2012_FINAL.pdf; Access Year 2012.
- 3 European Commission. 2013 Working Conditions-Working Time Directive. <http://ec.europa.eu/social/main.jsp?catId=706&langId=en&intPageId=205>; Access Date December 2013.
- 4 House J. Calling time on doctors' working hours. *Lancet* 2009;**373**:2011-12.
- 5 The Lancet. Doctors' training and the European Working Time Directive. *Lancet* 2010;**375**:2121.
- 6 Leff D, Aziz O, Darzi A. Trucks, planes, and scalpels - Is there an evidence-based approach to surgeons' working hours? *Arch Surg* 2007;**142**:817-20.
- 7 Parthasarathy S. Sleep and the medical profession. *Curr Opin Pulm Med* 2005;**11**:507-12.
- 8 Dr. Foster Hospital Guide. 2011 www.drfoosterhealth.co.uk; Access Date February 2011.
- 9 UEMS. 2012 The Union of European Medical Specialists. www.uems.net; Access Year 2012.
- 10 Macdonald EB, Ritchie KA, Murray KJ, et al. Requirements for occupational medicine training in Europe: a Delphi study. *Occup Environ Med* 2000;**57**:98-105.
- 11 Macdonald E, Baransky B, Wilford J. Occupational Medicine in Europe: Scope and Competencies. In: Health WECfEa, ed. Health, Environment and Safety in Enterprises Series n. 3. Bilthoven, The Netherlands, 2000.
- 12 Ballester M, Cordell N, Rodriguez Jareno MC, et al. A European survey of professional bodies representing occupational medicine specialists. *Occup Med (Oxf)* 2012;**62**:366-70.
- 13 Cashman C, Slovak A. The occupational medicine agenda: Routes and standards of specialization in occupational medicine in Europe. *Occup Med (Oxf)* 2005;**55**:308-11.
- 14 De Schryver A, Claesen B, Meheus A, et al. European survey of hepatitis B vaccination policies for healthcare workers. *Eur J Public Health* 2011;**21**:338-43.
- 15 Rodriguez-Juareno M, Serra C, Demou E, et al. European Working Time Directive: systematic review for evidence based decision making. SUMMARY REPORT. In:

- 1
2
3 Medicine USoO, ed. http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%20%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf; UEMS Section of Occupational Medicine, 2011.
- 4
5
6
7
8
9 16 UEMS. 2010 The Newsletter of European Medical Specialists.
10 http://www.uems.eu/data/assets/pdf_file/0014/1463/1466.pdf.
- 11
12 17 UEMS. Meetings of the Board & Council of UEMS- Report. In: European Union of
13 Medical Specialists;
14 http://www.uems.eu/data/assets/pdf_file/0011/1235/UEMS_2011.37_-_report_-_UEMS_Council_6-8.10.2010_Napoli.pdf, ed. Napoli (Italy), 2011.
- 15
16
17 18 Bannai A, Tamakoshi A. The association between long working hours and health: A
18 systematic review of epidemiological evidence. *Scand J Work Environ Health* 2013.
- 19
20 19 Dembe AE, Erickson JB, Delbos RG, et al. The impact of overtime and long work
21 hours on occupational injuries and illnesses: new evidence from the United States.
22 *Occup Environ Med* 2005;**62**:588-97.
- 23
24 20 Johnson JV, Lipscomb J. Long working hours, occupational health and the changing
25 nature of work organization. *Am J Ind Med* 2006;**49**:921-9.
- 26
27 21 Kivimaeki M, Batty GD, Hamer M, et al. Using Additional Information on Working
28 Hours to Predict Coronary Heart Disease. *Ann Intern Med* 2011;**154**.
- 29
30 22 Liu Y, Tanaka H, Fukuoka Heart Study G. Overtime work, insufficient sleep, and
31 risk of non-fatal acute myocardial infarction in Japanese men. *Occup Environ Med*
32 2002;**59**:447-51.
- 33
34 23 Sokejima S, Kagamimori S. Working hours as a risk factor for acute myocardial
35 infarction in Japan: case-control study. *BMJ* 1998;**317**:775-80.
- 36
37 24 Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated with
38 long working hours: A review of the current position. *Occup Environ Med*
39 1997;**54**:367-75.
- 40
41 25 Virtanen M, Ferrie JE, Singh-Manoux A, et al. Long working hours and symptoms
42 of anxiety and depression: a 5-year follow-up of the Whitehall II study. *Psychol Med*
43 2011;**41**:2485-94.
- 44
45 26 Virtanen M, Stansfeld SA, Fuhrer R, et al. Overtime work as a predictor of major
46 depressive episode: a 5-year follow-up of the Whitehall II study. *PloS One*
47 2012;**7**:e30719.
- 48
49 27 Gopal R, Glasheen JJ, Miyoshi TJ, et al.. Burnout and internal medicine resident
50 work-hour restrictions. *Arch Intern Med* 2005;**165**:2595-600.
- 51
52 28 Reed DA, Fletcher KE, Arora VM. Systematic Review: Association of Shift Length,
53 Protected Sleep Time, and Night Float With Patient Care, Residents' Health, and
54 Education. *Ann Intern Med* 2010;**153**:829-42.
- 55
56
57
58
59
60

- 1
2
3 29 Sargent MC, Sotile W, Sotile MO, et al. Quality of Life During Orthopedic Training
4 and Academic Practice Part 1: Orthopedic Surgery Residents and Faculty. *J Bone*
5 *Joint Surg Am* 2009;**91A**:2395-405.
6
- 7 30 Fletcher KE, Underwood W, Davis SQ, et al. Effects of work hour reduction on
8 residents' lives - A systematic review. *JAMA* 2005;**294**:1088-100.
9
- 10 31 Black C, Frost D. *Health at work - an independent review on sickness absence*.
11 London: The Stationary Office, 2011.
12
- 13 32 Waddell G, Burton K. *Is work good for your health and wellbeing?* London: The
14 Stationary Office, 2006.
15
- 16 33 Butterworth P, Leach LS, Strazdins L, et al. The psychosocial quality of work
17 determines whether employment has benefits for mental health: results from a
18 longitudinal national household panel survey. *Occup Environ Med* 2011;**68**:806-12.
19
- 20 34 Lockley SW, Landrigan CP, Barger LK, et al. When policy meets physiology - The
21 challenge of reducing resident work hours. *Clin Orthop* 2006:116-27.
22
- 23 35 ICD-10. 2012 International Classification of Diseases.
24 <http://www.who.int/classifications/icd/en/>; Access Year 2012.
25
- 26 36 van Uffelen JGZ, Wong J, Chau JY, et al. Occupational Sitting and Health Risks A
27 Systematic Review. *Am J Prev Med* 2010;**39**:379-88.
28
- 29 37 Kirsling RA, Kochar MS, Chan CH. An evaluation of mood states among 1st-year
30 residents. *Psychol Rep* 1989;**65**:355-66.
31
- 32 38 Bernard B. A critical review of epidemiologic evidence for work-related
33 musculoskeletal disorders of the neck, upper extremity and low back. In: NIOSH, ed.
34 Publication No. 9741. Cincinnati: National Institute for Occupational Safety and
35 Health, 1997.
36
- 37 39 Steenstra IA, Verbeek JH, Heymans MW, et al. Prognostic factors for duration of
38 sick leave in patients sick listed with acute low back pain: a systematic review of the
39 literature. *Occup Environ Med* 2005;**62**:851-60.
40
- 41 40 Ayas NT, Barger LK, Cade BE, et al. Extended work duration and the risk of self-
42 reported percutaneous injuries in interns. *JAMA* 2006;**296**:1055-62.
43
- 44 41 Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor
45 vehicle crashes among interns. *N Engl J Med* 2005;**352**:125-34.
46
- 47 42 Firth-Cozens J. Emotional Distress in Junior House Officers. *BMJ* 1987;**295**:533-36.
48
- 49 43 Fisman DN, Harris AD, Rubin M, et al. Fatigue increases the risk of injury from
50 sharp devices in medical trainees: Results from a case-crossover study. *Infect*
51 *Control HospEpidemiology* 2007;**28**:10-17.
52
53
54
55
56
57
58
59
60

- 1
2
3 44 Hayasaka Y, Nakamura K, Yamamoto M, et al. Work environment and mental
4 health status assessed by the general health questionnaire in female Japanese doctors.
5 *Ind Health* 2007;**45**:781-86.
6
- 7 45 Kirkcaldy BD, Trimpop R, Cooper CL. Working hours, job stress, work satisfaction,
8 and accident rates among medical practitioners and allied personnel. *Int J Stress*
9 *Manag* 1997;**4**:79-87.
10
- 11 46 Rosta J, Aasland OG. Work Hours and Self rated Health of Hospital Doctors in
12 Norway and Germany. A comparative study on national samples. *BMC Health Serv*
13 *Res* 2011;**11**.
14
- 15 47 Stamp T, Termuhlen P, Miller S, et al. Before and after resident work hour
16 limitations: an objective assessment of the well-being of surgical residents. *Curr Surg*
17 2005;**62**:117-21.
18
- 19 48 Sundquist J, Johansson SE. High demand, low control, and impaired general health:
20 working conditions in a sample of Swedish general practitioners. *Scand J Pub Health*
21 2000;**28**:123-31.
22
- 23 49 Varma A, Marott J, Stoltenberg C, et al. With long hours of work, might depression
24 then lurk? A nationwide prospective follow-up study among Danish senior medical
25 consultants. *Scand J Work Environ Health* 2012;**38**:418-26.
26
- 27 50 Zahrai A, Chahal J, Stojimirovic D, et al. Quality of life and educational benefit
28 among orthopedic surgery residents: a prospective, multicentre comparison of the
29 night float and the standard call systems. *Can J Surg* 2011;**54**:25-32.
30
- 31 51 Dembe AE, Delbos R, Erickson JB. Estimates of injury risks for healthcare
32 personnel working night shifts and long hours. *Quality & Safety in Health Care*
33 2009;**18**:336-40.
34
- 35 52 Lindfors PM, Nurmi KE, Meretoja OA, et al. On-call stress among Finnish
36 anaesthetists. *Anaesthesia* 2006;**61**:859-64.
37
- 38 53 Šelb J, Albreht T. Mortality rates of medical doctors in Slovenia in 1985 to 1999.
39 *Zdravniški vestnik* 2000:147-148.
40
- 41 54 Lee S, McCann D, Messenger J. Working Time Around the World: Trends in
42 working hours, laws and policies in a global comparative perspective. Geneva,
43 Switzerland: International Labour Office, 2007.
44
- 45 55 Elder A, Paterson C. Sharps injuries in UK health care: a review of injury rates, viral
46 transmission and potential efficacy of safety devices. *Occup Med-Oxford*
47 2006;**56**:566-74.
48
- 49 56 Naghavi SHR, Sanati KA. Needlestick injuries: Does left-handedness matter? *Am J*
50 *Infect Control* 2009;**37**:341-41.
51
- 52 57 Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury
53 to car occupants: population based case control study. *BMJ* 2002;**324**:1125-28A.
54
55
56
57
58
59
60

1
2
3 58 BMA. 2013 European Working Time Directive, <http://bma.org.uk/practical-support-at-work/ewtd>. Access Date December 2013.

4
5
6 59 Wilson AM, Weston G. Application of Airline Pilots Hours to Junior Doctors. *BMJ* 1989;**299**:779-81.

7
8
9 60 The European Specialist Medical Qualifications Order 1995. 1995 Statutory Instruments, 1995 No. 3208, MEDICAL PROFESSION, The European Specialist Medical Qualifications Order 1995, <http://legislation.data.gov.uk/uksi/1995/3208/made/data.htm?wrap=true>. Access Date December 2013.

10
11
12 61 Boorman S. NHS Health and Well-being. The Boorman Review. Leeds, 2009.

13
14
15
16 62 Williams S, Michie S, Pattani S. Improving the health of the NHS workforce. Report of the partnership on the health of the NHS Workforce. London: The Nuffield Trust, 1998.

17 18 19 20 21 22 **Figure legend**

23
24 **Figure 1.**Results of the search strategy, using search engines on PubMed and EMBASE (December 2011) and screening of references lists of identified full papers, study selection and quality assessment.

1
2
3
4
5
6
7 **European Working Time Directive and doctors' health. A Systematic review of the**
8 **available epidemiological evidence.**
9

10 **Running title:** Long working hours and doctors' health
11

12
13
14 ***Corresponding author**
15

16 Dr. Evangelia Demou
17 Healthy Working Lives Group
18 Institute of Health and Wellbeing
19 University of Glasgow
20 Glasgow, G12 8RZ
21 Tel: +44 141 330 3559
22 E-mail: evangelia.demou@glasgow.ac.uk
23

24 Maria Cruz Rodriguez-Jareño^{1,2}, Evangelia Demou^{3,*}, Sergio Vargas-Prada⁴, Kaveh A
25 Sanati^{3,5}, Alenka Škerjanc⁶, Pedro G. Reis⁷, Ritva Helimäki-Aro⁸, Ewan B.
26 Macdonald³, Consol Serra^{1,4,9,10}, on behalf of the UEMS Section of Occupational
27 Medicine¹¹.
28
29
30
31

- 32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
1. Catalan and Spanish Societies of Occupational Medicine, Barcelona, Spain.
 2. Department of Medical Sciences. School of Medicine. Universitat de Girona. Girona. Spain
 3. Institute of Health and Wellbeing, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, United Kingdom
 4. CiSAL - Centre for Research in Occupational Health, Universitat Pompeu Fabra, Barcelona, Spain.
 5. Occupational Health Department, Epsom & St Helier University Hospitals NHS Trust, Surrey, United Kingdom
 6. Clinical Institute of Occupational, Traffic and Sports Medicine, University Medical Centre, Ljubljana, Slovenia.
 7. College of Occupational Medicine, Portuguese Medical Association, Lisbon, Portugal.
 8. Helsinki City Occupational Health Centre, Helsinki, Finland.
 9. Occupational Health Service, Parc de Salut MAR, Barcelona, Spain.
 10. CIBER of Epidemiology and Public Health. Spain.
 11. UEMS Section of Occupational Medicine. <http://www.uems-occupationalmedicine.org>

51
52 | Word Count: 4,667,794
53
54
55
56
57
58
59
60

ABSTRACT

Objective: To summarise the available scientific evidence on the health effects of exposure to working beyond the limit number of hours established by the European Working Time Directive (EWTD) on physicians.

Design: A systematic literature search was conducted in PubMed and Embase. Study selection, quality appraisal and data extraction were carried out by independent pairs of researchers using pre-established criteria.

Setting: Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Participants: The total number of participants was 14,338.

Primary and secondary outcome measures: Health effects classified under the International Classification of Diseases (ICD-10).

Results: Over 3,000 citations and 110 full articles were reviewed. From these, eleven studies of high or intermediate quality carried out in North America, Europe and Japan met the inclusion criteria. Six studies included medical residents, junior doctors or house officers and the five others included medical specialists or consultants, medical, dental and general practitioners and hospital physicians. Evidence of an association was found between percutaneous injuries and road traffic accidents with extended hours/day or very long working weeks (LWH). The evidence was insufficient for mood disorders and general health. No studies on other health outcomes were identified.

Conclusions: LWH could increase the risk of percutaneous injuries and road traffic accidents, and possibly other incidents at work through the same pathway. While associations are clear, the existing evidence does not allow for an established causal or "dose-response" relationship between LWH and incidents at work, or for a threshold number of extended hours above which there is a significantly higher risk and the hours physicians could work and remain safe and healthy. Policy makers should consider safety issues when working on relaxing EWTD for doctors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The first systematic review, to our knowledge, on the effects of Long Working Hours (LWH) on physicians' health and safety.
- A systematic literature search conducted in PubMed and Embase with over 3,000 citations and 110 full articles reviewed.
- Eleven studies of high or intermediate quality carried out in North America, Europe and Japan, involving physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.
- The findings of this review confirmed that long working hours are associated with both an increased risk of needlestick injuries and road traffic accidents. Evidence was assessed as low or insufficient for mood disorders and general health.
- This review uncovered the lack of literature on the effect of long working hours on the general health of doctors, a topic that has important health ramifications not only for physicians but for patients too.

KEY WORDS: Working time, "Physicians"[MeSH], "Morbidity"[MeSH], "Occupational Injuries"[MeSH], Systematic review.

INTRODUCTION

The European Working Time Directive (EWTD),[1] applicable to all occupations across the EU, requires a maximum working week of 48 hours and establishes rest periods.[2, 3] Since it came into force in healthcare in 2009, it has been associated with concerns about the provision of health services including continuity of care, lower staffing levels, introduction of shift working, a reduction in training time and the adequate supervision of junior doctors.[4, 5] The large inter-country variations in physicians working hours as well as the mandatory controls over work hours across occupations raises further questions as to the basis of selecting and setting these limits and restrictions.[6] There is evidence of variable compliance to the EWTD within health care across Europe.[4, 5] The medical profession is also increasingly feminised with potential implications for women of childbearing age, which may coincide with the time in the profession where long working hours (LWH) are more likely to happen (i.e. during residency). Constraint on public-sector finances and increasing health care demands, have stimulated the debate on physicians' working hours,[7] with some evidence showing that the quality of health care is positively correlated with the number of physicians available to deliver that care.[8]

The Union of European Medical Specialists (UEMS) was created in 1958 to represent medical specialists in the EU, promote a high standard of training and practice at European level and facilitate the free movement of physicians across European countries.[9] The Occupational Medicine section was created in 1997 and is involved in issues related to specialist training, professional practice and research;[10] elaborating and publishing reference documents,[11] conducting and contributing to surveys,[12-14] and working in partnership with other key European groups.

The trigger for this project was a request by the Council of the UEMS to its Occupational Medicine Section for a position statement on the EWTD and possible health consequences to physicians of a potential removal of this professional group from the current EWTD 48 hours per week limit. ~~An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.[15-17]~~
An evidence based approach was taken by the Section and a systematic review of the literature was undertaken.[15]

LWH have been associated with several adverse effects on workers' health, such as hypertension, cardiovascular disease, stress, depression, musculoskeletal disorders,

1
2
3
4
5
6 chronic infections, diabetes, general health complaints and all-cause mortality in a
7 variety of occupational groups.^{[15-23][18-26]} In physicians, there is some evidence
8 suggesting that LWH can result in impacts such as stress, depression, burnout, injuries,
9 fatigue and sleep deprivation,^{[24-26][27-29]} and overwork has been considered one of
10 the most stressful features of physicians' work.^{[24][27]} Some evidence exists of the
11 beneficial effect of reducing the number of working hours on the quality of life of
12 medical residents ^{[27][30]} and on burnout,^{[24][27]}

13
14
15
16 However, the relationship between work and health is complex. There is a substantial
17 body of evidence showing that worklessness is associated with poorer health, whereas
18 work is generally good for health and well-being.^[31, 32] provided that the work
19 environment is reasonably acceptable and supportive.^[33]

20
21
22
23 Occupational and non-occupational exposures may play an important role such as the
24 pattern and distribution of working hours, breaks, and recovery periods. Also,
25 psychosocial and organisational factors, such as workload, job control, managers and
26 peer support, training opportunities, individual characteristics and attitudes may be
27 important.^[6, 34]

28
29
30
31 Finally, physicians are a highly qualified, devoted and motivated professional group.
32 Despite other existing reviews of a more general occupational approach, a review
33 focused on physicians is warranted.

34
35
36 The aim of this project was to systematically review whether long-working hours
37 (LWH) -i.e. defined as more than the 48 hour per week limit imposed by the EWTD-
38 are associated with health effects –i.e. classified under the International Classification of
39 Diseases (ICD-10) ^{[32][35]}- in physicians, and to examine what these associations are.
40 This review does not include the potential impact of LWH on patient care or physician
41 training.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Field Code Changed

Field Code Changed

METHODS

The systematic review sought to respond to the following research question: are LWH associated with health effects in physicians? For the purpose of this review, exposure to LWH was defined as working for more than 48 hours per week.^{[4][1]} Health outcomes included any disease as defined in the ICD-10 ~~[32] and work related injuries.[35] and work related injuries.~~ If self-assessed tools on health status were used, only those validated were considered. Burnout, stress and outcomes such as individual symptoms, signs or biological markers (blood pressure, ECG, etc.) were not considered. Physicians of any medical, surgical or community speciality, working in any possible setting (hospitals, primary health care, etc.), as well as trainees, residents, junior house officers or postgraduate interns, were included.

Study identification

Electronic searches were carried out using PubMed and EMBASE as search engines (December 2011). Our search strategy was similar in both databases and consisted of a combination of the following keywords and Mesh terms: night shift, morning shift, evening shift, afternoon shift, shift work, rotating shift, shift combination, shift duration or length, shift system, clockwise rotation, shift roster, extended shifts, night work, evening work, work schedule, work hours, starting time, early start, irregular working hours, direction of rotation, overwork, extended hours, shift rota, workload, work schedule tolerance, sleep deprivation, sleep disorders, chronobiology disorders, circadian rhythm, psychomotor performance, circadian disruption, vigilance, alertness, wakefulness, drowsiness, fatigue, insomnia, hypersomnolence, dyssomnia, eveningness, morningness, neurocognitive performance, concentration difficulties, arousal, health, morbidity, mortality, disease, illness, stress, strain, distress, accident, injur*, death, suicid*, education, medical, physician, medical staff, hospital, doctor, surgeon, house officers, medical school, surgery, surgical.

In addition, the references lists of articles selected for inclusion were carefully reviewed to identify additional studies.

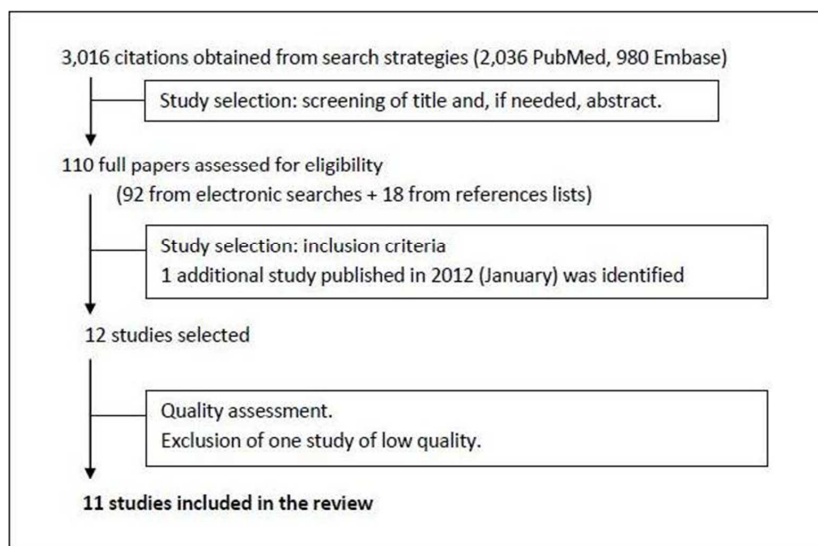
Study selection

6

1
2
3
4
5
6 Studies were included if they measured the association between the exposure to LWH
7 and health effects in physicians, used an observational epidemiological (i.e. cohort,
8 case-control, cross-sectional) or experimental design, ~~and were published in English,
9 French, German, Italian, Slovenian or Spanish.~~ Articles relating to on-call, night or shift
10 work, but with unknown exposure or exposed to less than 48 working hours per week
11 were excluded. They were also excluded if the working groups were other than
12 physicians or addressed only other exposures or outcomes (i.e. patient safety, fatigue,
13 sleep deprivation, social or family disruption). No limitation was set for languages.
14
15
16
17

18 A total of 2,036 citations were obtained from PubMed and 980 non-duplicated citations
19 using Embase, yielding a total of 3,016 citations that were all screened by independent
20 pairs of reviewers. All titles and, where necessary, abstracts were reviewed. Ninety two
21 potentially suitable publications were identified from the electronic searches, and 18
22 further studies were identified from the references lists, yielding a total of 110 studies
23 ~~for all of which published in English, French, German, Italian, Slovenian and Spanish.~~
24 For all of them the full text was obtained and reviewed by independent pairs of
25 reviewers. Disagreements within pairs were resolved by discussion and, where
26 necessary, by a third reviewer who made the final decision. All authors participated as
27 reviewers for screening the citations and full papers using well defined and pre-
28 established criteria. Ninety nine articles were excluded at this stage. One further study
29 was identified that was published after the search period. Finally, 12 papers were
30 considered for quality assessment (Figure 1).
31
32
33
34
35
36
37

38 **Figure 1.** Results of the search strategy, using search engines on PubMed and EMBASE (December
39 2011) and screening of references lists of identified full papers, study selection and quality assessment.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



The methodological quality of the 12 studies was assessed by independent pairs of reviewers. A standardized 16 point scale based on CONSORT and STROBE statements (Table 1) and adapted from a previous systematic review [33] was used. [36] was used. It includes 16 items grouped into 6 areas: 1) objectives, 2) study design, 3) target population and sample, 4) variables, 5) data sources, collection and measurement, and 6) statistical methods. Each item was rated as 1 (the requirement was met), 0.5 (the requirement was partially met) or 0 (the requirement was not or unclearly met). Disagreements within pairs of reviewers were resolved by consensus or, where necessary, by a third reviewer. For each of the 12 studies, a final score based on the sum of all items was assigned and the percentage was calculated based on a maximum score of 16. Study quality was rated as low, moderate or high if it scored less than 60%, between 60% and 79.9%, and 80% or more of the maximum score, respectively.

One article of low quality was excluded [34] and a total of 11 studies of intermediate or high methodological quality were included for the purpose of this review (figure 1).

One article of low quality was excluded [37] and a total of 11 studies of intermediate or high methodological quality were included for the purpose of this review (figure 1).

Data extraction

Selected information was extracted from each paper, including publication year, country of origin, study design, setting, study population, sample size, response rate, measure of working hours, definition used for LWH, health outcomes and their measurement, and

1
2
3
4
5
6 main results on point risk estimates or frequencies of health outcomes, and their
7 corresponding 95% confidence interval (95%CI), and whether the analyses were
8 adjusted for potential confounders.
9

10 11 12 13 **Evidence synthesis**

14 To summarise the results on the relationship between LWH and health effects, levels of
15 evidence synthesis was performed. This was based on the methodological quality, study
16 design and the consistency of the study outcomes. The following criteria were based on
17 two previous relevant systematic reviews,^[3538, 3639]
18

19
20
21 Strong evidence: consistent results in more than two studies of high quality.

22
23 Moderate evidence: consistent results in one high quality study and one intermediate, or
24 between some studies of intermediate quality.
25

26
27 Insufficient evidence: identification of only one study or inconsistent results across
28 studies;

29
30 Evidence of no association: consistent results of a non-association in two or more
31 studies.

32
33 A measure of the possible magnitude of the association was attempted using the
34 following criteria based on the association point estimate (RR = relative risk, rate ratio
35 or odds ratio) when available or otherwise the comparison between two frequencies was
36 used:
37

- 38 • high: $RR > 3.00$
- 39 • intermediate: $RR = 1.50-3.00$
- 40 • low: $RR = 1.01-1.49$
- 41 • no association: $RR=1.00$
- 42 • unclear
- 43
- 44
- 45

46 47 48 **RESULTS**

49 We identified 11 studies related to LWH and health effects in physicians that were
50 eligible for inclusion. The outcome of the methodological quality assessment is given in
51 table 1.
52

53
54 Methodological quality was appraised as high for 3 of the 11 studies, with scores
55 ranging from 84 to 94%. The other 8 studies were considered as intermediate quality as
56

57
58
59
60
9

Field Code Changed

Field Code Changed

1
2
3
4
5
6 their scores ranged from 63 to 78%. The majority of all included studies received
7 positive scores on items describing the study objectives, design and the study
8 population (items from areas 1, 2 and 3), as well as the description of exposure and
9 outcome variables (item 4). However, although data sources and collection were well
10 described, reliability and validity of exposure to LWH and health outcome measures
11 had low scores (items 5b and 5c). The statistical methods were in general appropriate,
12 however the confounding variables were not measured in several studies and, as can be
13 seen, the studies did not describe how they addressed missing data (items 6a and 6b).
14
15
16
17
18
19

20 **Study characteristics:**

21 The characteristics of the included studies are described in table 2.
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1. Methodological quality appraisal of the included studies

Study ID		Ayas 2006 [37][40]	Barger 2005 [38][41]	Firth-Cozens 1987 [39][42]	Fisman 2007 [40][43]	Hayasaka 2007 [41][44]	Kirkcaldy 1997 [42][45]	Rosta 2011 [43][46]	Stamp 2005 [44][47]	Sundquist 2000 [45][48]	Varma 2012 [46][49]	Zahrai 2011 [47][50]
1	Objectives	Are the objectives or hypotheses of the research described in the paper?	1	1	1	1	1	1	1	1	1	1
2	Study design	Is the study design presented?	1	1	1	1	1	1	1	1	1	1
3a	Target population	Do the authors describe the target population they wanted to research?	1	1	1	1	1	1	1	1	1	1
3b	Sample	Was a random sample of the target population taken? AND was the response rate 60% or more?	0.5	0.5	1	0.5	0.5	0.5	1	1	1	0.5
3c	Sample	Is participant selection described?	1	1	1	1	0.5	1	0	1	1	1
3d	Sample	Is participant recruitment described, or referred to?	1	1	1	1	1	1	1	1	1	0
3e	Sample	Are the inclusion and/or exclusion criteria stated?	1	1	1	1	0.5	0.5	1	1	1	0.5
3f	Sample	Is the study sample described? (minimum description: sample size, gender, age and occupation)	1	1	0	1	1	1	0	0	0	1
3g	Sample	Is the number of participants at each stage of the study reported?	1	1	1	0.5	1	0.5	1	1	1	1
4	Variables	Are the measures of long working hours and the health outcome described?	1	1	0.5	1	1	1	1	1	1	1
5a	Data sources, collection	Do authors describe the source of their data (e.g., official registry, health survey) AND how the data were collected?	1	1	1	1	1	1	1	1	1	1
5b	Measurement	Was reliability of the measure(s) of long working hours mentioned or referred to?	0	0	0	1	0	0	0	1	0	0
5c	Measurement	Was the validity of the measure(s) of long working hours mentioned or referred to?	1	1	0	0	0	0	0	0	0	0
5d	Measurement	Were health outcomes assessed by objective measures or validated self-reporting instruments?	0	1	1	1	1	0	1	1	1	1

6a	Statistical methods	Were appropriate statistical methods used and described, including those for addressing confounders?	0.5	1	0.5	1	0.5	0.5	1	0.5	1	1	0.5
6b	Statistical methods	Were the numbers/% of participants with missing data for long working hours and the health outcome indicated AND If more than 20% of data in the primary analyses were missing, were methods used to address missing data?	0	0	0	0.5	0	0	0	0	0	1	0.5
Total score** (%)			12.0 (75)	13.5 (84)	11.0 (69)	13.5 (84)	11.0 (69)	10.0 (63)	10.5 (66)	12.5 (78)	12.0 (75)	15.0 (94)	11.0 (69)
Quality rate***			interm	high	interm	high	interm	interm	interm	interm	interm	high	interm

** Maximum score = 16; *** Quality rate (%): low=<60; intermediate (interm)=60-79; high=80-100.

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Table 2. Characteristics of the included studies.

Study ID	Country Of Study Population	Design*	Setting	Participants and sample size (response rate)	Working hours	Health outcomes	Quality score (%)
Ayas 2006 [37] Ayas 2006 [40]	United States	Cross-over Cohort, prospective (1 year) / Case-crossover	Hospital	Interns in postgraduate residency programs Sample size: 2,737 (80%)	Mean (SD) hrs worked/month: 249.8 (75.3-self) . Self-reported, monthly survey. Strong correlation (Pearson $r=0.76$; $p < 0.001$) with hours worked 244 (69.3) from work diaries of randomly selected subset of 192 interns. Extended periods (>20 hrs/day or more consecutive hours) vs. non extended periods (first-12 hrs at work or less consecutive hours).	Self-reported percutaneous injuries	12.0 (75)
Barger 2005 [38] Barger 2005 [41]	United States	Cohort, prospective (1 year)	Hospital	Residents first postgraduate year (interns). Sample size: 2,554 (75/37) (80%)	Average 70.7+26.0 Mean (SD) hrs worked/week: 70.7 (26.0) . Extended shift (≥ 24 hrs) vs. non extended shift (<24 hours). Self-reported, validated.	Self-reported and documented motor vehicle crashes.	13.5 (84)
Firth Cozens 1987 [39] Firth Cozens 1987 [42]	United Kingdom	Cohort, prospective (1 year)	Hospital	Junior house officers Sample size: 170 (72%)	Mean number of hours per week = 90.6 hours (include on call). Self-reported.	GHQ-12 (case: score ≥ 2) and SCLDS, self-reported	11.0 (69)
Fisman 2007 [40] Fisman 2007 [43]	United States and Canada	Cross-over Case-Crossover	Hospital	Medical trainees vs. other HCW. Sample size: 109 vs. 241 (46%)	Median number of hours per week: medical trainees = 70; other HCW = 40 ($p < 0.001$). Self-reported, high reliability.	Reported percutaneous injuries to employee health care service.	13.5 (84)
Hayasaka 2007 [44] Hayasaka 2007 [44]	Japan	Cross-sectional	Hospital, clinics, other	Female physicians Sample size: 367 (63%)	Comparison of increasing number of hrs/week from ≤ 30 to >50 , self-reported.	GHQ-30 (case: score ≥ 8), self-reported	11.0 (69)
Kirkcaldy 1997 [42] Kirkcaldy 1997 [45]	Germany	Cross-sectional	Not specified	Medical and dental practitioners. Sample size: 2,500 (not specified)	Long hours: mean 58.36 hrs/week SD 9.16 Short hours: mean 38.17 hrs/week SD 7.72 Self-reported.	Self-reported traffic accidents	10.0 (63)
Rosta 2011 [43] Rosta 2011 [46]	Germany and Norway	Cross-sectional	Hospital	Hospital physicians Sample size Participants: 1,917 (58%) in Germany and 1,072 (65%) in Norway answered the questionnaire. From survey responders, 1,260 (65.7%) Germans and 562 (52.4%) Norwegians (58% and 65%) were included in the analysis after applying further inclusion criteria.	German vs. Norwegian physicians (%): Hours per day $>9 = 58.8$ vs. 26.7 60 hours on-call per month = 63.4 vs. 18.3 Self-reported.	Validated questionnaire on self-rated health	10.5 (66)

Formatted: Font: (Intl) Arial Unicode MS

Formatted: Font: (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Formatted: Font: Font color: Black, (Intl) Arial

Stamp-2006- [44] Stamp 2005 [47]	United States	Before-and-after	Hospital	Residents of general surgery Sample size: 28 (97%)	Changes of work patterns, after reduction from 90-110 to 78-80 work hrs/week.	SF-36, mental health; BDI, depression; self-reported	12.5 (78)
Sundquist-2000- [45] Sundquist 2000 [48]	Sweden	Cross-sectional	Primary care	General practitioners Sample size: 1,004 (72%)	Overtime defined as working at least 47 hrs/week. Self-reported.	Swedish SF-36, impaired mental health, self-reported	12.0 (75)
Varma-2012- [46] Varma 2012 [49]	Denmark	Cohort, prospective (20 months)	Hospital	Senior medical consultants Sample size: 2,790 (62%)	Long work hours (>40hrs/week). Self-reported.	Depression: redemption of anti-depressive drug prescriptions	15.0 (94)
Zahrai-2014- [47] Zahrai 2011 [50]	Canada	Cohort, prospective (6 months)	Hospital	Orthopaedic surgery residents Sample size: 16 (not specified)	Night float (n=9): 77.8% did >80h/week at baseline; 71.4% at follow-up). Standard call (n=7): 57.1% did >80h week at baseline; 80% at follow-up.	SF-36, mental health score, self-reported	11.0 (69)

* Follow-up period in brackets for prospective cohort studies; GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Five had been carried out in North America (4 in the United States [37, 38, 40, 44][40, 41, 43, 47] and 1 in Canada [50]), five in European countries (Denmark,[49] Germany,[45] Norway and Germany [43]; Sweden,[48] and the United Kingdom [42]) and one study in Japan.[44] Four used a prospective cohort design (follow-up ranging from 6 to 20 months), 2 were case-crossover, 4 cross-sectional, and 1 was a before and after study. Overall, the total number of participants was 14,338 and included medical residents, junior doctors or house officers only working in hospitals, medical specialists or consultants, medical and dental practitioners, general practitioners, hospital physicians and one study included female physicians from a community service. Most studies (n=9) compared different working hour patterns within the same group of physicians, one compared physicians from two different countries,[46] and one included other health care workers as the comparison group.[43]

LWH was defined as more than 48hours/week in most studies, and some did not provide a definition. Two studies considered LWH below 48/week.[46, 48] All the included studies investigated health effects associated with working more than 48h/week, with number of hours ranging between <30 to 110hours/week. One paper studied the effects of an increasing number of hours from 30 to more than 50h/week.[44] Others studied more than 40h/week,[49] 47h/week,[48] above 58h/week [46] (two studies) and 6 studies referred to more than 70h/week,[37, 40, 44, 47][40-43, 47, 50] one of which compared 78-80h/week to 90-110 weekly hours.[47] Information on working hours was self-reported in nine studies, with reasonably good validity only in two studies [37, 38][40, 41] and reliability in one.[43] In the other two studies it was obtained from established work schedules.[44, 47][47, 50]

Identified health outcomes that fulfilled the inclusion criteria were percutaneous injuries, motor vehicle accidents, mood disorders and general health. Information was self-reported in all studies using well known validated questionnaires, except three studies that used documented information on motor vehicle crashes.[40] reported percutaneous injuries [42] and antidepressant prescription data as a surrogate of depression.[49]

Summary of findings:

Table 3 shows the findings from each of the 11 studies.

Table 3. Results on the association between long working hours and identified health effects in physicians.

Health outcome	Main results	Adjustment by confounders	Study ID
Percutaneous injuries	Odds ratio (95% CI) for injuries during extended (>20 hours/day) vs. non extended periods (first 12 hours at work): All percutaneous injuries: 1.61 (1.46-1.78); Injuries reported to OH: 1.83 (1.48-2.28); Injuries in the ICU: 1.87 (0.69-5.04); Injuries in the operating room or labour and delivery: 1.77 (1.49-2.09); Injuries in the ICU, non-ICU, or ED: 2.17 (1.56-3.00)	Not adjusted <u>Time of day and circadian influences</u>	Ayas-2006[37] Ayas-2006[40]
Percutaneous injuries	Medical trainees vs. other health care workers: total median working hours: 70 vs. 40 hours (p<.001); median previous working hours at the time of injury: 6.5 vs. 5 hours (p<.001). Odds ratio (95% CI) for self-reported fatigue: <u>> work > 40h</u> in the past week: 3.550 (2.06-5.92); <u>work</u> during more than 5d in past week: 4.220 (4.46-7.15); >12h at work before injury: 8.58 (3.7-19.86). Incidence rate ratio (95%CI) for <u>association between fatigue and injuries</u> and fatigue: all workers: 1.40 (1.03-1.90); medical trainees: 2.94 (1.71-5.07); other HCWs: 0.97 (0.66-1.42) (p=0.001 for heterogeneity).	Age and sex	Fisman-2007[40] Fisman-2007[43]
Motor vehicle accidents	<u>Relative riskOdds ratios</u> (95% CI), after extended shift (≥ 24hrs) vs. non extended shift (<24 hours): Crashes = 2.3 (1.6-3.3); Near miss accidents = 5.9 (5.4-6.3)	Age and sex	Barger-2006[38] Barger-2005[41]
Motor vehicle accidents	Incidence rates of driving accidents on house visits: Long hours (mean 58.36 hrs/week) = 0.10 (0.31) vs. short hours (mean 38.17 hrs/week) = 0.02 (0.18) <u>vs.</u> p<0.05	Not adjusted	Kirkcaldy-1997[42] Kirkcaldy-1997[45]
Mood disorders, depression	Hazard ratio (95% CI) hours/week intervals and redemption of anti-depressive drug prescription(reference group: 37-40 h/week): 25-36 h: 0.83 (0.24-2.82); 41-44 h: 0.95 (0.50-1.77); 45-49 h: 0.88 (0.43-1.78); 50-54 h: 0.83 (0.32-2.14); 55-59 h: 0.67 (0.15-2.94); >60 h: 0.48 (0.06-3.68). Cox regression analysis of work hours as a continuous variable: HR=0.93 (0.76-1.13)	Age, sex, marital status, medical specialty, decision authority at work, social support at work, quantitative work demands and previous redemption of AD drug prescription	Varma-2012[46] Varma-2012[49]
Mood disorders, GHQ-30	Prevalence of cases by working time (hours/week) ≤ 30 hours: 35.7% (41/115); >30 to 40 hours: 39.0% (39/100); >40 to 50 hours: 37.7% (26/69); >50 hours: 56.8% (46/81); p=0.0179 Stepwise multiple logistic regression, >50 h/wk. vs. ≤50 h/wk.: parameter 0.635 (p=0.0293)	Marital status, medical facility, position, and night duty.	Hayasaka-2007[44] Hayasaka-2007[44]
Mood disorders, GHQ-12 and SCLDS	No association was found between number of hours worked in a week and depression.	Not adjusted	Firth-1987[39] Firth-1987[42]
Mood disorders, SF-36	Scores when night float vs. standard call at baseline and follow-up: Mental health mean score (SD): baseline = 57.33 (22.63) vs. 65.71 (7.61); follow up = 52.00 (15.49) vs. 60.80 (11.45); p=0.72 Mental health component summary (SD), baseline = 34.84 (14.06) vs. 40.21 (7.61) ; follow up = 30.15 (10.71) vs. 42.40 (6.23); p=0.39 Regression analysis: increased number of hours in hospital correlated with significantly lower SF-36 scores in almost all domains.	Not adjusted	Zahrai-2011[47] Zahrai-2011[50]

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Health outcome	Main results	Adjustment by confounders	Study ID
Mood disorders, SF-36 and BDI	Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week); Mental health SF-36): no statistically significant improvement Individual questions BDI before and after duty hours limitations, only energy level statistically significant.	Not adjusted	Stamp-2005[44] Stamp-2005[47]
Mood disorders, SF-36	Odds ratio (95% CI)for working 47 hours per week or more: Impaired mental health, men: 1.59 (0.95-2.66); women: 1.86 (1.03-3.37)	Age and amount of time in practice	Sundquist-2000[45] Sundquist 2000[48]
General health, SF-36	SF-36: Scores when night float vs. standard call at baseline and follow-up: General health mean score (SD): baseline = 62.11 (17.47) vs. 77.57 (24.25); follow up = 56.43 (24.89) vs. 84.20 (16.50); p=0.41 Physical health component summary (SD): baseline = 46.16 (13.15) vs. 52.01 (13.33); follow up = 39.32 (9.80) vs. 56.15 (2.18); p=0.015 Vitality mean score (SD): baseline = 51.67 (14.58) vs. 51.43 (15.74); follow up = 48.57 (14.92) vs. 51.00 (10.84); p=0.20 Regression analysis demonstrated that the increased number of hours spent in hospital correlated with significantly lower general health, physical function, mental health, role emotional, social function and mental component summary scale scores (all p < 0.05)	Not adjusted	Zahrai-2011[47] Zahrai-2011[50]
General health, SF-36	SF-36, BDI: Improvement of levels before and after duty hours limitations from 90-110 to 78-80 hours/week); Physical health: no statistically significant differences.	Not adjusted	Stamp-2005[44] Stamp-2005[47]
General health, SF-36	SF-36: Odds ratio (95% CI) adjusted for age and time in practice, for working 47 hours per week or more: Impaired general health: men = 1.66 (1.00-2.77); women = 1.59 (1.00-3.17)	Age and amount of time in practice	Sundquist-2000[45] Sundquist 2000[48]
General health, SF-36	Self-rated health: Odds ratio (95% CI) of good self-rated health (logistic regression): Norwegian work time pattern**= 1.35 (1.03-1.77); working in Norway = 4.17 (3.02 - 5.73).	Age, sex and country of work	Rosta-2011[43] Rosta-2011[46]

**Not working more than 9 hours a day and having more than 60 hours a month on-call); GHQ-12= General Health Questionnaire-12 items; SCLDS= Symptom Checklist Depression Scale; BDI = Beck Depression Inventory II.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Percutaneous injuries: One study of high quality and one of intermediate quality, with non-adjusted analyses, showed consistent results in medical trainees. Ayas et al. found an increased risk of percutaneous injuries associated with working more than 20 hours/day compared to non-extended hour periods, except in intensive care units;[37] Fisman et al.[40] Fisman et al. found an association between self-reported fatigue and the number of working hours at the time of injury and a 3-fold increased risk of sharp injuries in medical trainees compared to other health care workers (median of working hours/week before the injury: 70 vs. 40;p<.001).[4043]

Field Code Changed

Field Code Changed

19
20
21
22
23
24
25
26
27
28
Motor vehicle accidents: Two studies of high and intermediate quality showed that long working weeks were associated with an at least two-fold increased risk. Barger et al. found adjusted increased risks for car crashes (OR 2.3; 95%CI 1.6-3.3) and near miss accidents (OR 5.9; 95%CI 5.4-6.3) associated with working extended shifts.[38] Kirkealdy et al.[41] Kirkealdy et al. showed that non-adjusted incidence rates of traffic accidents on house visits was five times as much when physicians worked for a mean of 58 hours/week compared to 38 hours/week (p<0.05).[4245]

Field Code Changed

Field Code Changed

29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
Mood disorders: Six studies of intermediate and high quality found contradictory results for mood disorders. Three of them, all of intermediate quality, provided evidence of an association between LWH and mental health problems. The prevalence of GHQ-30 cases was higher for female physicians working above 50 hours/week than for those working 30 or less hours/week (p<0.05).[44][44] and an increased adjusted risk of impaired mental health was found for men and women general practitioners who worked for 47 hours per week or more.[45] Zahrai et al.[48] Zahrai et al. found that increased number of hours spent by residents in hospital correlated significantly with lower mental health and mental component summary scale scores (SF-36).[47][50] Three other studies, one of which of high quality, did not find an association between depression or mood disorders and LWH. Varma et al. did not find higher adjusted risks of depression associated with increased number of hours in senior medical consultants, even when they worked for more than 60 hours per week.[46][49] Depression or mood disorders measured with GHQ-12, SCLDS or BDI, all validated tools for mental health, were not associated with increased number of working hours [39][42] nor improved after decreasing the number of hours from 90-110 to 78-80 hours per week in residents.[4447]

Field Code Changed

Field Code Changed

General health: Four studies of intermediate quality analysed the association between LWH and general health. Zahrai et al. found that increased number of hours spent by residents in hospital correlated significantly with poorer general health, physical function and vitality using SF-36.^{[47][50]} A comparative study of physicians in two different countries found that Norwegians showed higher non-adjusted prevalence of self-reported good health compared to physicians in Germany who worked longer hours.^{[43][46]} An increased adjusted risk of impaired general health was found for men and women general practitioners who worked for more than 47 hours per week.^{[45][48]} However, following the implementation of reducing the number of hours from an average of 90-110hours/week to 78-80hours/week did not lead to an overall improvement of residents self-reported physical health.^[4447]

Field Code Changed

Field Code Changed

Synthesis of the evidence:

The levels of evidence synthesis obtained from the analysis of the 11 studies included in this review are shown in table 4.

Table 4. Available scientific evidence on the health problems associated with long working hours in physicians: levels of evidence synthesis.

Health outcome	Degree of evidence*	Magnitude of the association**	Studies ID
Percutaneous injuries	++	++	Ayas 2006[37] , Fisman 2007[40] , Ayas 2006[40] , Fisman 2007[43]
MMotor Motor vehicle accidents	++	++	Barger 2005[38] , Kirkealdy 1997[42] , Barger 2005[41] , Kirkealdy 1997[45]
Mood disorders	+	+/-	Varma 2012[46] , Hayasaka 2007[41] , Firth Cozens 2001[39] , Zahrai 2011[47] , Stamp 2005[44] , Sundquist 2000[45] , Varma 2012[49] , Hayasaka 2007[44] , Firth Cozens 2001[42] , Zahrai 2011[50] , Stamp 2005[47] , Sundquist 2000[48]
General health	+	+/-	Zahrai 2011[47] , Stamp 2005[44] , Sundquist 2000[45] , Rosta 2011[43] , Zahrai 2011[50] , Stamp 2005[47] , Sundquist 2000[48] , Rosta 2011[46]

Formatted: Indent: Hanging: 0.1"

* Strong evidence (+++): consistent results in more than 2 studies of high quality; Moderate evidence (++) : consistent results in two studies of high quality, or one high quality study and one intermediate, or between some studies of intermediate quality; Insufficient evidence (+): identification of only one

study or inconsistent results across studies; Evidence of no association (-): consistent results of a non-association in two or more studies.

** Magnitude of the association: it refers to the magnitude of the association point estimate (RR = relative risk, rate ratio or odds ratio): high (+++) if $RR > 3$; intermediate (++) if $RR = 1.5-3$; low (+) if $RR < 1.5$; no association (-); unclear (+/-).

There is moderate evidence of an association between LWH and percutaneous and motor vehicle accidents in physicians. This evidence comes from one study of high quality and another of intermediate quality both for percutaneous injuries, and for motor vehicle accidents and the magnitude of this association could be intermediate.

For mood disorders and general health there is a low or insufficient level of evidence of an association with LWH in physicians. This comes from 6 studies on mood disorders and 4 on general health of high and intermediate methodological quality and inconsistent results among them. No conclusion can be drawn about the magnitude of such associations if existed.

DISCUSSION

This review found moderate scientific evidence for a positive association of intermediate magnitude between exposure to LWH and percutaneous injuries and motor vehicle accidents in physicians. Evidence was assessed as low or insufficient for mood disorders and general health.

To our knowledge, this is the first systematic review on the effects of LWH on physicians' health and safety. The extensive searches were restricted to indexed journals. We systematically identified, selected and assessed the methodological quality of studies by means of independent pairs of reviewers. The quality assessment form and the levels of evidence used in this review were based on CONSORT and STROBE statements and on previous systematic reviews.^{[33, 35, 36][36, 38, 39]} To give some estimate of the potential magnitude of the effect, we added levels based on the point estimates of measures of association provided by the studies. However, such levels had not been previously established.

Strengths and limitations of the studies

1
2
3
4
5
6 Four studies had a longitudinal prospective design, however only two of them used a
7 robust methodology. Two other studies used a crossover design, which reduces the
8 likelihood of individual variability and confounding, and were considered well
9 designed. Four studies, all rated as intermediate methodological quality, were cross
10 sectional in design and therefore it is difficult to draw causal relationships from them.
11 Although reverse causality cannot be ruled out from cross-sectional designs, it is
12 unlikely that poorer health determines longer working hours than their healthier peers.

13
14
15
16 One study used a quasi-experimental design but lacked a control group. Also, because
17 of different designs used across the included studies, different estimates of the effects
18 were used that may not be directly comparable.
19

20
21 Other limitations include the variability, validity and reliability of working hours, which
22 in most studies was self-reported. Although only those papers specifying the number of
23 working hours were accepted, shift and night work might have worked as confounders
24 too, as it is difficult to acknowledge which proportion of the health effects observed was
25 due exclusively to the LWH component and not due, for instance, to stress, fatigue or
26 sleep deprivation. Moreover, the studies did not discriminate between time spent
27 actively working or asleep while on call, though the EWTD considers all hours on call
28 as working time. Likewise, it is possible that participants were aware that the study was
29 conducted to assess associations between the number of hours worked and health
30 outcomes. Therefore, there might be a volunteer bias in those doctors who work
31 extended hours. To minimise this bias, a case-cross over analysis has been performed in
32 three of the included study [40, 41, 43].
33
34
35
36
37
38

Formatted: Font: (Intl) Arial Unicode MS

39
40 Health outcomes were measured mainly based upon self-report, with the exception of
41 documented motor vehicle crashes, [37][40] reported percutaneous injuries [39][42] and
42 register-notified anti-depressive drug prescriptions. [45] ~~No studies with other objective~~
43 ~~measures of health (e.g., [48] No studies with other objective measures of health (e.g.,~~
44 mortality) or mental disease (e.g., hospital data) were identified. However, self-reported
45 or perceived health was assessed by validated and widely used instruments, especially
46 when health status (general, mental or physical health) or ill-health symptoms are
47 evaluated. Nonetheless, this raises the possibility that the observed associations might
48 reflect differences in propensity to report health problems when they occur rather than
49 true differences in the risk of worse health status. We cannot rule this out, but the higher
50 propensity for reporting among those who work for longer hours and poorer work
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6 schedule patterns would have to relate specifically to the reporting of ill-health rather
7 than non-ill health. It seems unlikely that major differences in propensity to report
8 would extend to a more concrete outcome.
9

10
11 The majority of the studies of this review took into account confounding variables in
12 their analyses, such as sex and age. However, none of the studies analysed the potential
13 effect of modifying factors, such as psychosocial aspects at work, including attitudes,
14 motivation, job requirements, demands and content, organisational climate, social
15 relationships at work, work satisfaction, supportive organisation, or the relative number
16 of physicians and other staff available for patient care. Neither were important aspects
17 outside of work, such as life events or lifestyles, taken into account. The study of
18 Japanese female physicians found significant differences by marital status with higher
19 GHQ scores for those who were married.^[4144] There are significant differences in the
20 number of physicians per capita across different countries and this together with the
21 structure and organisation of health services are potential confounders too that were not
22 addressed in the selected studies across countries.
23
24
25
26
27
28

29
30 A relevant outcome from this review would be to establish a threshold number of
31 extended hours above which there is a significantly higher risk. There is a lack of
32 evidence for a dose-response relationship and nor does the evidence give any indication
33 for a threshold number of hours that physicians could work and remain safe and healthy.
34

35
36 Finally, the heterogeneity of the included studies did not allow a more quantitative
37 synthesis, and a level of evidence approach was used instead.
38
39
40

41 **Comparison with other studies**

42
43 Our findings of an association between LWH and injuries and accidents in physicians
44 are consistent with research in other occupational groups. Dembe et al. carried out a
45 longitudinal survey in the US including more than 10,000 workers from a variety of
46 occupations and settings.^{[46][19]} A strong dose-response effect (adjusted for age,
47 gender, occupation, industry and region) was found between LWH and injuries above
48 40h/week and 8h/day; jobs with overtime schedules were associated with a 61% higher
49 injury hazard rate compared to jobs without overtime; working at least 12 hours per day
50 was associated with a 37% increased hazard rate, and working at least 60 hours per
51 week was associated with a 23% increased hazard rate. They concluded that LWH
52
53
54
55
56

57
58
59
60
22

Field Code Changed

Field Code Changed

1
2
3
4
5
6 might indirectly precipitate workplace injuries through a causal process by inducing
7 fatigue or stress in workers. In a separate study assessing injury risks to health care
8 personnel, Dembe et al. demonstrated that the risk of injury when working overtime or
9 at least 60 h per week among physicians and nurses was statistically significant.[51] In
10 our review we found that information about the length of shift work varied across
11 studies, some analysing shifts of up to twenty four hours. Work that included such shifts
12 was more strongly associated with accidents and injuries.[3740, 3841]

Field Code Changed

13 We found insufficient evidence of an association between LWH and mood disorders,
14 other diseases and general health in physicians, despite some scientific evidence
15 suggesting that LWH increase morbidity and mortality in other occupations.[16-2319-
16 26]

Field Code Changed

17 Possible explanations for these inconsistencies might be the scarcity of high quality
18 research, and the fact that some of the included papers did not fully address the effect of
19 confounding factors, and the possibility that working as a physician might have a
20 protective effect by itself, for instance through higher motivation and social recognition
21 relative to other occupations.

22 Stamp et al., in the only before and after study, did not find significant differences for
23 mood disorder or general health before and after implementing requirements to reduce
24 working schedules to 80h/week in residents.[44][47] It is debatable, however, whether
25 any conclusions can be drawn from the impact of reducing extremely high working
26 hours (90-110hours/week) to very high working hours (78-80hours/week).

27 ~~Although we searched for and identified literature describing associations between~~
28 ~~LWH and increased mortality in doctors,[48, 49] none of those studies specified the~~
29 ~~number of hours worked, and therefore were not included.~~

30 Although we searched for and identified literature describing associations between
31 LWH and increased mortality in doctors,[52, 53] none of those studies specified the
32 number of hours worked, and therefore were not included.

33 **Recommendations for future research**

34 Further research, including well designed prospective and retrospective longitudinal
35 studies, is needed in this field to establish on scientific grounds what number of hours
36
37
38
39

1
2
3
4
5
6 are safe, both to patients and physicians. Also studies on long term health effects should
7 be considered.
8

9
10 This review was aimed to study exclusively possible detrimental health effects of LWH
11 (more than 48 hours per week) to physicians. Other systematic reviews should be
12 conducted addressing issues, such as the impact of working hours on doctor's well-
13 being and quality of life, the quality of junior doctors training, the quality and continuity
14 of care and impact on patient safety. Also, from a staffing perspective, the economic
15 and social burden of sick leave and physicians leaving the profession are important
16 issues that were beyond the scope of this review and that should be considered in future
17 research. ~~Other established criteria [50]~~Other established criteria [54] that working
18 hours should be 'family friendly', promote gender equality, enhance productivity or
19 facilitate worker choice and influence over working hours, were not addressed. Further
20 research is needed in these other areas.
21
22
23
24
25
26
27

28 **Conclusions**

29
30 The findings of this review have confirmed that long working hours are associated with
31 both an increased risk of needlestick injuries and road traffic accidents. The fact that
32 these associations are labelled moderate in this review, should not preclude safety
33 procedures and measures being assessed and reassessed to ensure maximum physician
34 and patient safety. The reduction of needlestick injuries requires improved use of safe
35 sharp devices, compliance with safe working procedures, training and regular audits of
36 working practices, particularly for junior doctors who are at greatest risk of needlestick
37 injuries, possibly due to inadequate training.^[51, 52][55, 56] The risk of road traffic
38 accidents could be reduced by discouraging driving after very long shifts (more than 16
39 hours) and where there is sleep deprivation.^[53][57] Transport should be provided by
40 the employer in these situations. This is a pragmatic recommendation which recognises
41 that long working hours have not been eliminated as a result of the EWTD.
42
43
44
45
46
47

48 This review uncovered the lack of literature on the effect of long working hours on the
49 general health of doctors, a topic that has important health ramifications not only for
50 physicians but for patients too. However, the paucity of available studies, which does
51 not allow for a causal or dose-response relationship to be established, raises further
52 questions about the evidence-base of the current 48 hour limit, especially as this is not
53
54
55
56
57
58
59
60

1
2
3
4
5
6 | enforced strictly and junior doctors, for example in the UK, may opt-out.^{[54][58]} It may
7 | be relevant that the EWTD was not based entirely on science but also took into account,
8 |
9 | as does all EU legislation, the views of "social partners".^{[3][3]}
10

11 | It is likely that the mechanism for these increased health and safety risks is fatigue, and
12 | our finding of increased risk of accidents to staff, may also be associated with increased
13 | risk of clinical errors. Patient safety was not the purpose of this review but long working
14 | hours are well recognised to cause decrement in performance both in health care and
15 | other professions, where the performance of staff can be safety critical, such as airline
16 | pilots, and professional drivers.^{[55][59]}
17

18 |
19 |
20 | In addition the EWTD has been associated with real concerns about the adequacy of the
21 | training of doctors given their reduced exposure to patient care, and the lack of
22 | experience of the patient journey, imposed by adherence to the EWTD.^{[4][4]} This is
23 | potentially exacerbated at the same time by the constraints on the overall duration of
24 | training imposed by other EU directives.^{[56][60]} Further reviews of the EWTD, with
25 | regard to this unique group of workers, need to take into account other social factors
26 | such as the impact on patient care. This is particularly the case when all health care
27 | systems are under strain because of burgeoning demands and limited resources.^{[4][4]}
28
29
30
31

32
33
34 | The findings of this systematic review lead to the suggestion of the following guidelines
35 | in the event of non-compliance with the EWTD: 1) long shifts should be avoided to
36 | protect both physicians' health and patient safety and no shift should be longer than 16
37 | hours (and then exceptionally);^[28] 2) Physicians should be discouraged from driving
38 | after long shifts to reduce the risk of motor accidents;^[41, 45] 3) rigorous attention
39 | should be paid to reducing the risk of sharps injuries;^[40, 43] 4) organisational aspects
40 | such as workload and job control, as well as the pattern and distribution of working
41 | hours, breaks and recovery periods should be carefully taken into account, in order to
42 | avoid fatigue and sleep deprivation that could lead to mistakes and accidents;^[61, 62] 5)
43 | Physicians should work in supportive psychosocial environments, in teams, and with
44 | adequate training and supervision as their wellbeing is important also for the health of
45 | their patients.^[61, 62]
46
47
48
49
50
51

52 | Further research is required to establish any longer term effects such as on mortality and
53 | mental health, also the impact of the nature of the work organisation taking into account
54

Field Code Changed

Field Code Changed

1
2
3
4
5
6 the psychosocial aspects of the physicians working and non-working lives, and to
7 determine how many hours are safe for physicians to work.
8
9

10 11 **ACKNOWLEDGMENTS**

12 Leena Isotalo, Trial Search Coordinator at the Cochrane Occupational Safety and
13 Health Review Group, designed and conducted the final search of the evidence using
14 Medline and Embase databases.
15
16

17 18 19 **CONFLICT OF INTERESTS**

20 None. No financial relationships with any organisations that might have an interest in
21 the submitted work, and no other relationships or activities that could appear to have
22 influenced the submitted work.
23
24

25 26 27 **FUNDING**

28 The Section of Occupational Medicine of the UEMS provided limited support to the
29 work of all authors (MCR, ED, SVP, KS, AS, PR, RH), with the exception of the senior
30 authors (EBM, CS). The expenses of one meeting of the core group (MCR, ED, SVP,
31 EBM, CS) were also funded by the Section. **Role of funding source:** The Section of
32 Occupational Medicine of the UEMS acted in its role of promoting and contributing to
33 the research in Occupational Medicine.
34
35
36
37
38

39 40 **AUTHORS' CONTRIBUTIONS:**

41 Mari Cruz Rodríguez-Jareño, Evangelia Demou, Sergio Vargas-Prada, Alenka Škerjanc,
42 Kaveh A Sanati, Ewan B. Macdonald and Consol Serra conceived and submitted the
43 design, carried out the acquisition of data, analysis and interpretation of data, drafted the
44 article and revised it.
45
46

47 Pedro G. Reis and Ritva Helimäki-Aro contributed to acquisition of data, analysis and
48 interpretation of data, drafted the article and revised it.
49

50 All authors gave final approval of the version to be published, and agree to be
51 accountable for all aspects of the work.
52
53
54

1
2
3
4
5
6 **ETHICS COMMITTEE APPROVAL** was not sought as no patients were involved in
7 this study.
8
9

11 REFERENCES

- 12 1 EUR-Lex. Directive 2003/88/EC of the European Parliament and of the Council of 4
13 November 2003 concerning certain aspects of the organisation of working time. In:
14 Union OJotE, ed. Brussels: Official Journal of the European Union, 2003.
15
- 16 2 EPHA. 2012 EPHA Briefing on the European Working Time Directive (EWTd)
17 http://www.eph.org/IMG/pdf/EPHA_Briefing_EWTD_Oct2012_FINAL.pdf;
18 Access Year 2012.
19
- 20 3 European Commission. 2013 Working Conditions-Working Time Directive.
21 <http://ec.europa.eu/social/main.jsp?catId=706&langId=en&intPageId=205>; Access
22 Date December 2013.
23
- 24 4 House J. Calling time on doctors' working hours. *Lancet* 2009;**373**:2011-12.
25
- 26 5 The Lancet. Doctors' training and the European Working Time Directive. *Lancet*
27 2010;**375**:2121.
28
- 29 6 Leff D, Aziz O, Darzi A. Trucks, planes, and scalpels - Is there an evidence-based
30 approach to surgeons' working hours? *Arch Surg* 2007;**142**:817-20.
31
- 32 7 Parthasarathy S. Sleep and the medical profession. *Curr Opin Pulm Med* 2005;**11**:507-
33 12.
34
- 35 8 Dr. Foster Hospital Guide. 2011 www.drfoosterhealth.co.uk; Access Date February
36 2011.
37
- 38 9 UEMS. 2012 The Union of European Medical Specialists. www.uems.net; Access
39 Year 2012.
40
- 41 10 Macdonald EB, Ritchie KA, Murray KJ, Gilmour WH. Requirements for
42 occupational medicine training in Europe: a Delphi study. *Occup Environ Med*
43 2000;**57**:98-105.
44
- 45 11 Macdonald E, Baransky B, Wilford J. Occupational Medicine in Europe: Scope and
46 Competencies. In: Health WECfEa, ed. Health, Environment and Safety in Enterprises
47 Series n. 3. Bilthoven, The Netherlands, 2000.
48
- 49 12 Ballester M, Cordell N, Rodriguez Jareno MC, Serra C, Med USO. A European
50 survey of professional bodies representing occupational medicine specialists. *Occup
51 Med (Oxf)* 2012;**62**:366-70.
52
- 53 13 Cashman C, Slovak A. The occupational medicine agenda: Routes and standards of
54 specialization in occupational medicine in Europe. *Occup Med (Oxf)* 2005;**55**:308-
55 11.
56

1
2
3
4
5
6 14 De Schryver A, Claesen B, Meheus A, van Sprundel M, Francois G. European
7 survey of hepatitis B vaccination policies for healthcare workers. *Eur J Public Health*
8 2011;**21**:338-43.
9

10 ~~45~~15 Rodriguez-Juareno M, Serra C, Demou E, et al. European Working Time
11 Directive: systematic review for evidence based decision making. SUMMARY
12 REPORT. In: Medicine USoO, ed. [http://www.uems-](http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf)
13 [occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-](http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf)
14 [%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf](http://www.uems-occupationalmedicine.org/sites/default/files/old_userfiles/File%203%20-%20EWTD%20UEMS%20REPORT%2005%2010%202011.pdf); UEMS Section of
15 Occupational Medicine, 2011.
16

17 16 UEMS. 2010 The Newsletter of European Medical Specialists.
18 [http://www.uems.eu/ data/assets/pdf file/0014/1463/1466.pdf](http://www.uems.eu/data/assets/pdf_file/0014/1463/1466.pdf).
19

20 17 UEMS. Meetings of the Board & Council of UEMS- Report. In: European Union of
21 Medical Specialists;
22 [http://www.uems.eu/ data/assets/pdf file/0011/1235/UEMS_2011.37 - report -](http://www.uems.eu/data/assets/pdf_file/0011/1235/UEMS_2011.37_-_report_-_UEMS_Council_6-8.10.2010_Napoli.pdf)
23 [UEMS Council 6-8.10.2010 Napoli.pdf](http://www.uems.eu/data/assets/pdf_file/0011/1235/UEMS_2011.37_-_report_-_UEMS_Council_6-8.10.2010_Napoli.pdf), ed. Napoli (Italy), 2011.
24

25 18 Bannai A, Tamakoshi A. The association between long working hours and health: A
26 systematic review of epidemiological evidence. *Scand J Work Environ Health* 2013.

27 ~~46~~19 Dembe AE, Erickson JB, Delbos RG, Banks SM. The impact of overtime and long
28 work hours on occupational injuries and illnesses: new evidence from the United
29 States. *Occup Environ Med* 2005;**62**:588-97.
30

31 ~~47~~20 Johnson JV, Lipscomb J. Long working hours, occupational health and the
32 changing nature of work organization. *Am J Ind Med* 2006;**49**:921-9.
33

34 ~~48~~21 Kivimaeki M, Batty GD, Hamer M, et al. Using Additional Information on
35 Working Hours to Predict Coronary Heart Disease. *Ann Intern Med* 2011;**154**.
36

37 ~~49~~22 Liu Y, Tanaka H, Fukuoka Heart Study G. Overtime work, insufficient sleep, and
38 risk of non-fatal acute myocardial infarction in Japanese men. *Occup Environ Med*
39 2002;**59**:447-51.
40

41 ~~20~~23 Sokejima S, Kagamimori S. Working hours as a risk factor for acute myocardial
42 infarction in Japan: case-control study. *BMJ* 1998;**317**:775-80.
43

44 ~~24~~24 Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated
45 with long working hours: A review of the current position. *Occup Environ Med*
46 1997;**54**:367-75.
47

48 ~~22~~25 Virtanen M, Ferrie JE, Singh-Manoux A, et al. Long working hours and
49 symptoms of anxiety and depression: a 5-year follow-up of the Whitehall II study.
50 *Psychol Med* 2011;**41**:2485-94.
51

52 ~~23~~26 Virtanen M, Stansfeld SA, Fuhrer R, Ferrie JE, Kivimaki M. Overtime work as a
53 predictor of major depressive episode: a 5-year follow-up of the Whitehall II study.
54 *PloS One* 2012;**7**:e30719.
55
56
57
58
59
60

- 1
2
3
4
5
6 | [2427](#) Gopal R, Glasheen JJ, Miyoshi TJ, Prochazka AV. Burnout and internal medicine
7 resident work-hour restrictions. *Arch Intern Med* 2005;**165**:2595-600.
8
9 | [2528](#) Reed DA, Fletcher KE, Arora VM. Systematic Review: Association of Shift
10 Length, Protected Sleep Time, and Night Float With Patient Care, Residents' Health,
11 and Education. *Ann Intern Med* 2010;**153**:829-42.
12
13 | [2629](#) Sargent MC, Sotile W, Sotile MO, Rubash H, Barrack RL. Quality of Life During
14 Orthopedic Training and Academic Practice Part 1: Orthopedic Surgery Residents
15 and Faculty. *J Bone Joint Surg Am* 2009;**91A**:2395-405.
16
17 | [2730](#) Fletcher KE, Underwood W, Davis SQ, Mangrulkar RS, McMahon LF, Saint S.
18 Effects of work hour reduction on residents' lives - A systematic review. *JAMA*
19 2005;**294**:1088-100.
20
21 | [2831](#) Black C, Frost D. *Health at work - an independent review on sickness absence*.
22 London: The Stationary Office, 2011.
23
24 | [2932](#) Waddell G, Burton K. *Is work good for your health and wellbeing?* London: The
25 Stationary Office, 2006.
26
27 | [3033](#) Butterworth P, Leach LS, Strazdins L, Olesen SC, Rodgers B, Broom DH. The
28 psychosocial quality of work determines whether employment has benefits for
29 mental health: results from a longitudinal national household panel survey. *Occup*
30 *Environ Med* 2011;**68**:806-12.
31
32 | [3134](#) Lockley SW, Landrigan CP, Barger LK, Czeisler CA. When policy meets
33 physiology - The challenge of reducing resident work hours. *Clin Orthop* 2006:116-
34 27.
35
36 | [3235](#) ICD-10. 2012 International Classification of Diseases.
37 <http://www.who.int/classifications/icd/en/>; Access Year 2012.
38
39 | [3336](#) van Uffelen JGZ, Wong J, Chau JY, et al. Occupational Sitting and Health Risks
40 A Systematic Review. *Am J Prev Med* 2010;**39**:379-88.
41
42 | [3437](#) Kirsling RA, Kochar MS, Chan CH. An evaluation of mood states among 1st-year
43 residents. *Psychol Rep* 1989;**65**:355-66.
44
45 | [3538](#) Bernard B. A critical review of epidemiologic evidence for work-related
46 musculoskeletal disorders of the neck, upper extremity and low back. In: NIOSH, ed.
47 Publication No. 9741. Cincinnati: National Institute for Occupational Safety and
48 Health, 1997.
49
50 | [3639](#) Steenstra IA, Verbeek JH, Heymans MW, Bongers PM. Prognostic factors for
51 duration of sick leave in patients sick listed with acute low back pain: a systematic
52 review of the literature. *Occup Environ Med* 2005;**62**:851-60.
53
54 | [3740](#) Ayas NT, Barger LK, Cade BE, et al. Extended work duration and the risk of self-
55 reported percutaneous injuries in interns. *JAMA* 2006;**296**:1055-62.
56
57
58
59
60

- 1
2
3
4
5
6 | [3841](#) Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor
7 vehicle crashes among interns. *N Engl J Med* 2005;**352**:125-34.
8
9 | [3942](#) Firth-Cozens J. Emotional Distress in Junior House Officers. *BMJ* 1987;**295**:533-
10 36.
11
12 | [4043](#) Fisman DN, Harris AD, Rubin M, Sorock GS, Mittleman MA. Fatigue increases
13 the risk of injury from sharp devices in medical trainees: Results from a case-
14 crossover study. *Infect Control HospEpidemiology* 2007;**28**:10-17.
15
16 | [4144](#) Hayasaka Y, Nakamura K, Yamamoto M, Sasaki S. Work environment and
17 mental health status assessed by the general health questionnaire in female Japanese
18 doctors. *Ind Health* 2007;**45**:781-86.
19
20 | [4245](#) Kirkcaldy BD, Trimpop R, Cooper CL. Working hours, job stress, work
21 satisfaction, and accident rates among medical practitioners and allied personnel. *Int*
22 *J Stress Manag* 1997;**4**:79-87.
23
24 | [4346](#) Rosta J, Aasland OG. Work Hours and Self rated Health of Hospital Doctors in
25 Norway and Germany. A comparative study on national samples. *BMC Health Serv*
26 *Res* 2011;**11**.
27
28 | [4447](#) Stamp T, Termuhlen P, Miller S, et al. Before and after resident work hour
29 limitations: an objective assessment of the well-being of surgical residents. *Curr Surg*
30 2005;**62**:117-21.
31
32 | [4548](#) Sundquist J, Johansson SE. High demand, low control, and impaired general
33 health: working conditions in a sample of Swedish general practitioners. *Scand J Pub*
34 *Health* 2000;**28**:123-31.
35
36 | [4649](#) Varma A, Marott J, Stoltenberg C, Wieclaw J, Kolstad H, Bonde J. With long
37 hours of work, might depression then lurk? A nationwide prospective follow-up
38 study among Danish senior medical consultants. *Scand J Work Environ Health*
39 2012;**38**:418-26.
40
41 | [4750](#) Zahrai A, Chahal J, Stojimirovic D, Schemitsch EH, Yee A, Kraemer W. Quality
42 of life and educational benefit among orthopedic surgery residents: a prospective,
43 multicentre comparison of the night float and the standard call systems. *Can J Surg*
44 2011;**54**:25-32.
45
46 | [4851](#) Dembe AE, Delbos R, Erickson JB. Estimates of injury risks for healthcare
47 personnel working night shifts and long hours. *Quality & Safety in Health Care*
48 2009;**18**:336-40.
49
50 | [52](#) Lindfors PM, Nurmi KE, Meretoja OA, et al. On-call stress among Finnish
51 anaesthetists. *Anaesthesia* 2006;**61**:859-64.
52
53 | [4953](#) Šelb J, Albreht T. Mortality rates of medical doctors in Slovenia in 1985 to 1999.
54 *Zdravniški vestnik* 2000:147-148.
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- | [5054](#) Lee S, McCann D, Messenger J. Working Time Around the World: Trends in working hours, laws and policies in a global comparative perspective. Geneva, Switzerland: International Labour Office, 2007.
- | [5155](#) Elder A, Paterson C. Sharps injuries in UK health care: a review of injury rates, viral transmission and potential efficacy of safety devices. *Occup Med-Oxford* 2006;**56**:566-74.
- | [5256](#) Naghavi SHR, Sanati KA. Needlestick injuries: Does left-handedness matter? *Am J Infect Control* 2009;**37**:341-41.
- | [5357](#) Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury to car occupants: population based case control study. *BMJ* 2002;**324**:1125-28A.
- | [5458](#) BMA. 2013 European Working Time Directive, <http://bma.org.uk/practical-support-at-work/ewtd>. Access Date December 2013.
- | [5559](#) Wilson AM, Weston G. Application of Airline Pilots Hours to Junior Doctors. *BMJ* 1989;**299**:779-81.
- | [5660](#) The European Specialist Medical Qualifications Order 1995. 1995 Statutory Instruments, 1995 No. 3208, MEDICAL PROFESSION, The European Specialist Medical Qualifications Order 1995, <http://legislation.data.gov.uk/ukxi/1995/3208/made/data.htm?wrap=true>. Access Date December 2013.
- | [5761](#) Boorman S. NHS Health and Well-being. The Boorman Review. Leeds, 2009.
- | [5862](#) Williams S, Michie S, Pattani S. Improving the health of the NHS workforce. Report of the partnership on the health of the NHS Workforce. London: The Nuffield Trust, 1998.

Formatted: EndNote Bibliography, Indent: Left: 0", Hanging: 0.19", Space Before: 0 pt, After: 0 pt, Line spacing: single

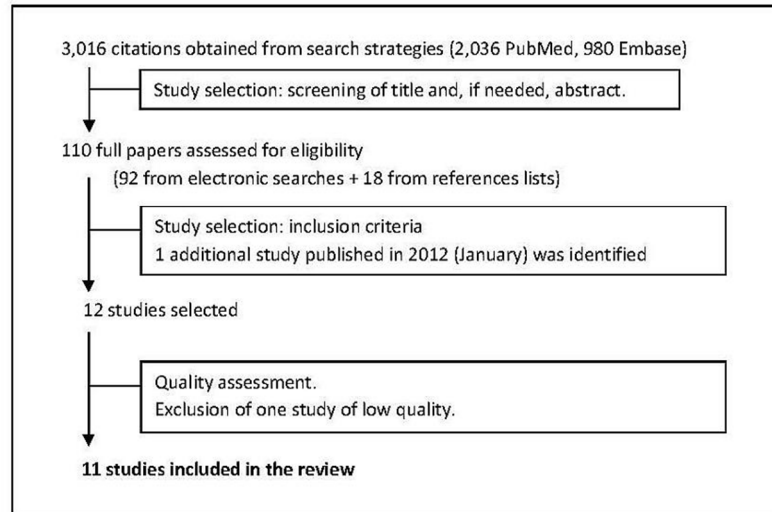


Figure 1. Results of the search strategy, using search engines on PubMed and EMBASE (December 2011) and screening of references lists of identified full papers, study selection and quality assessment.
90x59mm (300 x 300 DPI)



PRISMA 2009 Checklist

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8-9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8-9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8-9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2 for each meta-analysis).	8-9



PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10-11
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	12-13
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	18
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	9-19
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	19
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	21-23
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	24-25

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Page 2 of 2

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>