BMJ Open

Impact of intra-work rest breaks on doctors' performance and wellbeing: systematic review

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-062469
Article Type:	Original research
Date Submitted by the Author:	26-Apr-2022
Complete List of Authors:	O'Neill, Aimee; University of Southampton Faculty of Medicine Baldwin, David; University of Southampton Faculty of Medicine Cortese, Samuele; University of Southampton, Sinclair, Julia; University of Southampton, Academic Centre
Keywords:	MENTAL HEALTH, Human resource management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Word Count 3935

Title Page

Impact of intra-work rest breaks on doctors' performance and wellbeing: systematic review

Aimee O'Neill [1], David S. Baldwin [1,2], Samuele Cortese [1,3,4,], Julia M.A. Sinclair [1*]

[1] Clinical and Experimental Sciences Academic Unit, Faculty of Medicine, University of Southampton, UK
[2] University Department of Psychiatry and Mental Health, University of Cape Town, Cape Town, South Africa
[3] Centre for Innovation in Mental Health, School of Psychology, Faculty of Environmental and Life Sciences, University of Southampton, Southampton, UK.
[4] Solent NHS Trust, Southampton, UK.

*Correspondence: Professor Julia Sinclair
University Department of Psychiatry, College Keep, Terminus Terrace, Southampton, SO14 3DT, Tel: 023 82 310764 Fax: 023 82 310766 Email: julia.sinclair@soton.ac.uk

Keywords: Mental Health, Human resource management, wellbeing; fatigue, burnout

Abstract

Objectives: This systematic review seeks to summarise evidence on intra-work breaks and their associated effect on doctors' wellbeing and/or performance at work.

Methods: Embase, PubMed, Web of Science (Core Collection), and PsychINFO were systematically searched on 6.6.2021, with no restrictions on date/language, study design or date of publication. Methodological quality was appraised using Cochrane's Risk of Bias (ROB-2), Cochrane's Risk of Bias in Non-randomised Studies (ROBINS-I), and the Johanna Briggs Institute checklists for cross-sectional, cohort and qualitative studies. As a systematic review of the literature no ethical approval was required. Quantitative synthesis was not undertaken due to substantial heterogeneity of design and outcomes. Results are presented narratively.

Results: Database searches returned 10,557 results, and searches of other sources returned two additional records. Thirty-two papers were included in the systematic review, comprised of 29 unique studies, participants and topics, and three follow-up studies. A variety of wellbeing and performance outcome measures were used. Overall, findings indicate that intra-work breaks improved some measures of wellbeing and/or work performance. However, methodological quality was judged to be low with a high risk of bias in most included studies.

Discussion: Using existing evidence, it is not possible to conclude with confidence whether intra-work breaks improve wellbeing and/or work performance in doctors. There is much inconsistency regarding how breaks are defined, measured, and the outcomes used to assess effectiveness. Future research should seek to: a) define and standardise the measurement of breaks; b) use valid, reliable outcome measures to evaluate their impact on wellbeing and performance; and c) minimise the risk of bias in studies where possible.

PROSPERO registration number: CRD42020156924 (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=156924)

Strengths and limitations of this study

- To our knowledge this is the first systematic review of break-taking in doctors
- No limits were placed on design, country or language to ensure a comprehensive review of the subject area
- Review complies with PRISMA 2020 statement and was prospectively registered on PROSPERO before commencement
- As meta-analysis was not possible, data are qualitatively synthesised

Introduction

The overwhelming strain placed on health professionals across the globe in responding to the Covid-19 pandemic is well recognised.[1] However, this is on the backdrop of concern about the risk of burnout of doctors in training and the impact this has on patient care increasing over the last 20 years.[2-8] A report in 2019 by the British Medical Association (BMA) [2] suggested approximately 80% of UK doctors and doctors in training are at high or very high risk of burnout. Though figures vary depending on choice of outcome measure and health system, it is generally acknowledged that rates of burnout and psychiatric morbidity among doctors are worryingly high.[3] Impairment to doctors' wellbeing negatively affects patient care, [4] patient outcomes,[5] and increases the chance of medical errors,[6, 7] notwithstanding an association with reduction in clinical hours and retention of doctors.[8, 9] As such, the wellbeing of doctors is a concern for many organisations, and recommendations have been formulated to address burnout and improve doctors' wellbeing. [10, 11] These include the necessity to reduce doctor fatigue [12, 13] and many highlight the importance of breaks for reducing fatigue, improving patient safety, and promoting wellbeing at work. [13-15] In response to these recommendations and campaign efforts (e.g., the BMJ's "Give Us a Break" campaign [16]) in the UK, investments have been made to improve rest facilities. [17]

What constitutes a "break" within the work context is a wide and variably defined construct, including: holidays and annual leave, career breaks, as well as the temporary reprieve taken within a given shift at work (intra-work breaks). A systematic review of the impact of intra-work breaks in industrial settings showed that intra-work breaks in that context maintained performance and helped mitigate fatigue and accident risk. [18] However, it remains unclear whether intra-work breaks improve doctors' wellbeing and performance as, to our knowledge, no review has been conducted on break-taking literature in this population. This systematic review seeks to specifically understand the impact of *intra-work* breaks on doctors' wellbeing and/or their performance at work.

Method

This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 statement. The protocol was pre-registered with the International Prospective Register of Systematic Reviews (PROSPERO CRD42020156924). [19]. As a systematic review of the literature no ethical approval was required.

Patient and Public Involvement: This systematic review is part of a PhD thesis undertaken in the Centre for Workforce Wellbeing at the University of Southampton. As part of that process there was significant engagement with junior doctors, consultants and patients about the priorities for doctors' wellbeing and outcome measurement.

Eligibility criteria

The review included any empirical studies investigating the impact of intra-work breaks on doctors' wellbeing and/or performance.

In the absence of an established definition of an intra-work break we developed an operational one as follows: A cessation of work tasks for a period of up to an hour during a given shift, allowing the individual to temporarily remove themselves from the workspace, physically and/or mentally. An hour period was chosen, as this is typically the maximum duration of lunch breaks in other industries and, for sleep-related break interventions, this would differentiate shorter naps from the equivalent of overnight sleep.

Break 'interventions' could include opportunities to rest, mandating breaks, increased frequency of breaks, increased break duration, varied timing of breaks, or break activities (e.g. yoga, exercise).

Where the study design necessitated a comparator, this could include usual practice, missed work breaks, less frequent breaks, shorter break durations, or other break activities.

We included any empirical study design or investigation, undertaken primarily in qualified medical doctors (doctors comprising at least 50% of the sample).

No restriction was placed on study design (quantitative or qualitative), language, location, or date of publication.

Studies were excluded if:

1) the break under investigation occurred outside of work hours;
2) the break under investigation included a work-based activity (e.g. reflective practice or administration);
3) qualified doctors did not constitute the majority of the sample;
4) the design was not empirical (e.g. opinion pieces, reviews, theoretical modelling);
5) the break duration was longer than an hour.

The primary outcome of the systematic review was the measured effect(s) of break taking on doctors' wellbeing or work performance.

Search strategy

We searched, until 6th June 2021, Embase, PubMed, Web of Science (Core Collection), and PsycINFO databases, using Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH). Bramer et al. [20] estimate that this combination should ensure at least 83% coverage of available literature, though this figure is likely to be higher due to PsycINFO being a comparatively more relevant database in this subject area than those included in their calculation. Reference lists of key research papers or reviews were also searched for additional papers not retrieved by the search strategy.

The search comprised three blocks of terms and their synonyms relating to: 1) medical doctors, 2) intra-work breaks, and 3) an outcome measure of wellbeing (e.g. burnout, stress, anxiety, fatigue, sleep) and/or work performance (e.g. errors, job performance indicators, quality of care, staff absence). Syntactic variations were adapted for each database. See Supplementary Material for the search strategy used for each database.

Study selection

Search results were imported into EndNote X9® software and duplicates were automatically and manually removed. Each study title and/ or abstract was assessed by two independent assessors against the inclusion criteria. If disagreements occurred between assessors, consensus was achieved through arbitration by a third senior author. Where abstracts indicated potential relevance to the review, corresponding full text papers were screened for inclusion. If full text articles were not available in accessible databases, through inter-library loan, and/or relevant information was not fully explained in the text, authors were contacted for relevant data via e-mail (at least twice). If corresponding peer reviewed reports were not available, even after request to the corresponding author, conference abstracts were assessed and those with sufficient information for data extraction were included.

Data extraction and analysis

We extracted: first author; year of publication; participant demographics (training level/seniority, speciality/department, gender); location; sample size; study design; definition/type of break; interventions/activities under investigation (and any comparators); evaluated outcome measurements; and associated results. If reported, data extraction also included break prevalence, timing and duration of breaks, and hindrances or facilitators to break taking. Data extraction for each study was completed by the primary author using a standardised table and verified by a second, senior author.

Data were tabulated for cross-comparison and descriptive analysis. The outcomes of included studies were described according to whether they improve, reduce or have no effect on wellbeing and/or job performance outcome measures. Due to the substantial variability in study methods, populations and outcome measures used, no meta-analysis was conducted on the data.

Quality appraisals

An assessment of the quality of evidence was made by two reviewers independently using the Cochrane risk of bias tool for randomised control trials (ROB-2)[21]. The Cochrane ROBINS-I tool [22] was used to assess non-randomised studies of interventions. Both Cochrane tools allow for an overall risk of bias assessment (ROB-2: low risk of bias, some concerns, high risk of bias; ROBINS-I: low, moderate, serious, or critical risk of bias, or no information).

For other experimental designs, quality assessment was completed using the relevant Joanna Briggs Institute (JBI) checklists [23] for cross-sectional, cohort, and qualitative studies. Each question is answered with “yes”, “no”, “unclear” or “not applicable”. The JBI checklists do not provide an overall risk of bias, however, to allow for intra- and cross-study comparison, we have indicated the frequency (%) of possible “yes” answers within each study and across studies.

The quality of follow-up studies was assessed separately if the design and/or participants were dissimilar to the original paper.

Results

Insert Figure 1 about here

Following removal of duplicates, the titles and abstracts of 10,557 records were assessed for inclusion in the review (see figure 1). Supplementary searches yielded two further records. In total, 32 records met criteria for inclusion. Three records report follow-up data to original papers and as such 29 records contain unique participants and topics.

See Supplementary Table 1 for the summary of results.

There was substantial heterogeneity in study design, including randomised control/crossover trials (n=7), non-randomised studies of interventions (n=7), cross-sectional surveys (n=7), cohort (n=4), qualitative (n=6) and mixed-method studies (n=1).

Intervention studies generally comprised relatively small sample sizes, ranging from 7 to 56 participants (median: 27). Of these, the six randomised control trials had sample sizes ranging from 7 to 49 participants (median: 37). Survey and cohort studies were moderately sized, ranging from 27 to 2,805 participants (median: 294). Qualitative study sample sizes were varied, ranging from 5 to 116 participants (median: 25).

The break-related topics of investigation were also highly varied. Intervention studies investigated the effect of 'microbreaks' (particularly in the specialty of surgery), naps, yoga or exercise sessions, and standard 30-minute breaks. Surveys and cohort studies investigated a wide range of break-related topics, including: the impact of breaks on digital eye strain, reaction time, burnout, stress, affect, vehicle and work-related accidents, inappropriate prescribing, emotional exhaustion, work-home conflict, report errors and healthy eating behaviours. Qualitative methods were used to appraise break interventions as well as to investigate diverse topics such as the importance of breaks to new mothers' ability to continue breastfeeding following maternity leave, the potential of breaks to improve clinician wellbeing and fatigue, the culture surrounding breaks, and clinician opinions on them. Mixed-method data investigated the role of breaks on sharing and hiding ignorance.

Wellbeing and performance outcome measures were also dissimilar across studies. Given the substantial variability in types of intervention implemented, and measures of outcome (see Supplementary Table 1 for full details), inherent heterogeneity in the data meant that any quantitative synthesis could generate spurious findings, and so was not undertaken.

Impact of breaks on wellbeing and performance outcome measures

As study design and break types under investigation varied, they are described here by topic and data type to aid clarity, including: quantitative studies of standard 30-minute breaks, [24, 25] sleep-

related interventions (naps), [26, 27] yoga and mindfulness interventions, [28-31] microbreaks in surgery, [32-35] other microbreak interventions, [36, 37] surveys, [38-44] and cohort studies. [45-48] Qualitative data are grouped into qualitative evaluations of interventions [49, 50] and other qualitative studies, [51-54] and a single German sequential mixed-method study investigating the impact of breaks on opportunities for physicians to share (or hide) ignorance. [55] (see Supplementary Table 1).

Quantitative study findings: Break interventions

Results for standard 30-minute breaks were mixed. A German double-blind cross-over trial [24] saw no changes to attention, sleepiness or anxiety measured during the shift, whilst an Australian before/ after study [25] found breaks improved clinicians' tiredness, fatigue when measured at the end of each shift, and departmental performance (time to see patients, triage and target admission times).

Two sleep-related interventions [26, 27] conducted in the US showed overall improvement to wellbeing and performance during both day and night shifts. Twenty-minute midday naps in day shifts were associated with improvements in cognitive functioning and attentional failures in first year interns, [26] while 40-minute naps during night shifts showed improvement to reaction times, mood, sleepiness, and driving performance in Emergency Department (ED) staff. [27] However, no significant changes were seen in memory and simulations of intravenous tasks. .

Studies investigating yoga and mindfulness offered the one hour sessions within work hours. [28-31] These studies (two before/ after [28, 29] and two randomised controlled trials (RCTs) [30, 31]) found overall positive improvements to wellbeing and performance measures such as burnout, anxiety, depression, stress, blood pressure, sleep, professional fulfilment, interpersonal disengagement, resilience, and mindfulness. However, no changes were seen in heart rate, [29] subjective sleep scores, [28] sleep disturbances and affect. [31] The US study in faculty physicians [31] found that positive findings of reduced burnout, stress, anxiety, and depression, and increased professional fulfilment, were not sustained at a two-month follow-up; whilst another in US obstetric trainees [29] found an overall increase in participants' weight following the implementation of a yoga programme.

To reduce the common musculoskeletal difficulties associated with prolonged surgery, the effect of microbreaks (breaks of approximately 5 minutes or less) were tested in surgeons in Canada, USA and Germany, using parallel RCT, [34] randomised crossover trials [32, 33] and before/ after study design. [35]

Results were predominantly positive. Five-minute microbreaks every 30 minutes saw improvements to musculoskeletal strain, cortisol, attention, concentration, doctors' responses to stressful intra-operative events, intra- and post- operative impairment by fatigue, and stress – without prolonging the duration of a given surgery nor affecting patient outcomes. [33, 34] However, doctors' approval of this type of scheme depended on their preferred way of working. [34] Studies also tested microbreaks of a shorter duration (20-second pauses every 20 minutes and 1.5-2 minute breaks every 20-40 minutes), and despite the shorter break time, showed predominantly positive effects. [32, 35] Twenty-second microbreaks showed improvements to physical discomfort, muscular fatigue, and accuracy, [32] while breaks of 1.5-2 minutes showed improvement to musculoskeletal pain, physical performance and, for some surgeons, mental performance, with no or minimal effect on surgery duration, difficulty, complexity, distractions, work flow or mental/physical demands. [35] Additionally, the majority of surgeons expressed a desire to incorporate this type of shorter micropause into their regular routine. [35]

Other microbreak interventions included a Canadian study delivering micro-food breaks (six small meals) throughout the work day; [36] and (in France) a five minute mindfulness meditations prior to breaking bad news to patients. [37] Micro-food breaks were found to have positive effects on speed and accuracy, blood glucose levels, fluid intake, urine output, and caloric intake though no significant reduction in hypoglycaemic nutrition-related symptoms. [36] Five minute mindfulness meditations had a positive effect on performance during a simulated bad news consultation, however, it had no significant effect on doctors' stress, confidence, or self- or patient- perceived empathy. [37]

Quantitative study findings: Survey and cohort studies

Cross-sectional surveys investigated various topic areas and used a variety of measures to investigate the impact of break taking. A survey of radiologists in Saudi Arabia found that infrequent break taking was predictive of digital eye strain, [38], whilst in the UK [39] doctors reported lack of breaks as the most common barrier to healthy eating. Two studies (In Egypt and Germany) [40, 41] found that fewer breaks correlated with, or were predictors of, higher stress levels. Whereas a survey of physicians in private practice [42] found that break taking negatively correlated with work-home conflict and indirectly correlated with emotional exhaustion. However, a small survey of 46 Tunisian anaesthetists of varying grades [43] found no association between break-taking behaviours and levels of burnout. The survey of German doctors [41] also found that while shorter break duration was a predictor of work-related accidents, it was not a predictor of motor vehicle accident rates.

Additionally, one cross-national survey [44] showed break duration negatively correlated with doctors' work stress in Sweden but not in Germany.

Cohort studies were also prospective and retrospective in design and reported on a variety of measures. One prospective cohort study in Belgium Emergency Department physicians [45] found that greater use of fatigue reduction strategies (break activities) were associated with faster reaction times but not with levels of burnout. A UK study in trainees [46] found that the lack of breaks during shifts was associated with greater negative affect (worry, tiredness, impatience, frustration etc.) and less positive affect (competence, enjoyment, happiness etc.). A retrospective cohort study using secondary analysis of electronic records in the US [47] found that doctors were more likely to inappropriately prescribe opioids before than after a break, whilst another in Switzerland [48] showed that report errors (as a surrogate marker of fatigue) reduced after breaks, though this post-break effect waned as the week progressed.

Qualitative findings: Qualitative appraisals of break interventions

Two studies qualitatively appraised interventions. One [49] used individual interviews to follow-up the aforementioned Canadian micro-food break study, [36] and found that lack of time, access to break areas, and lack of food choices were barriers to adequate nutrition, which in turn impacted doctors' emotional and physical symptoms, their ability to work, and their interactions with colleagues and patients. However, the intervention created greater awareness of nutrition in the workplace and prompted some doctors to change their habits and eat more regularly.

Another small (n=5) qualitative study of an intervention [50] used a survey to appraise a weekly one hour intra-work exercise session in Canadian rheumatology fellows. Participants reported that work was a barrier to their desired exercise regime, and felt the program was an effective use of time and resources. The majority found that the programme increased their confidence and following the programme the majority were continuing to exercise more regularly.

Qualitative findings: Other

Other qualitative studies used focus groups and individual interviews with doctors, and thematically analysed discussions about various break-related topics with a wellbeing or performance component. [51-54]

One (UK) focus group study investigated themes regarding breaks as a potential strategy to improve general practitioner (GP) wellbeing. [51] GPs described breaks as a valuable, desirable opportunity to

remove oneself from the workplace that is a feasible wellbeing improvement strategy, though shorter coffee breaks were deemed more feasible than lunch breaks.

Another focus group study [53] investigated US Emergency Department doctors' thoughts about the function of breaks. Themes included doctors' need for breaks for cognitive and emotional functioning, however, when breaks were taken for the benefit of patients or productivity this was more acceptable than if they were taken for self-care alone. Doctors expressed the view that breaks had the potential to hinder work (though this was stated to have never been personally experienced) and that taking them required flexibility and attuned organisational skills. Additionally, any culture change around doctors' break taking was thought to require 'buy-in' from colleagues and other staff.

A UK focus group study[52] investigated the impact of Working Time Regulations on the experience of fatigue. Themes included fatigue being a threat to doctors' performance (e.g. efficiency and skills) and that this worsened with hunger or discomfort caused by missed breaks. Participants expressed that fatigue was still experienced despite the implementation of regulations, that rest areas were increasingly being reduced, and that senior staff seemed to lack awareness of trainee entitlements to rest.

Finally, an interview study [54] with doctors who were also new mothers found that whilst they valued the ability to breastfeed, this was dependent on their ability to take breaks to express milk.

Mixed-method findings

The only included mixed-method study [55] investigated the phenomenon of 'sharing ignorance' (detecting and sharing unknown knowledge and learning from failures) and 'hiding ignorance' (deliberately preventing knowledge sharing). The qualitative component of the study (individual interviews) identified breaks as an opportunity to share and hide ignorance, while the quantitative survey showed that breaks significantly facilitated sharing, but not hiding, ignorance.

Quality assessment

The methodological quality of included studies was rather low (see tables 1-5). The risk of bias in randomised studies ranged from 'some concerns' to 'high' (see table 1), whilst in quasi-experimental studies ranged from 'moderate' to 'critical' (see table 2), with most studies being at 'critical' risk of bias. This was predominantly due to inherent confounding, a lack of comparator or control groups,

the use of subjective criteria, and a lack of blinding to intervention status. No randomised or quasi-experimental studies had pre-published their protocols and/or analysis intentions.

Table 1. Risk of bias in Randomised crossover/controlled studies (Cochrane ROB-2)

Study	Domain							Overall risk of bias
	Bias due to randomization process	Bias from period and carryover effects	Bias due to deviations from intended interventions (effect of assignment to intervention)	Bias due to deviations from intended interventions (effect of adhering to intervention)	Bias due to missing outcome data	Bias in measurement of outcomes	Bias in selection of reported result	
Coburn (2006)[24]	Low	Low	Low	Low	Low	Low	Some concerns	Some concerns
Dorion (2013)[32]	Some concerns	Low	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns
Engelmann (2011)[33]	Low	Some concerns	Low	Some concerns	Low	Low	Some concerns	Some concerns
Engelmann (2012)[34]*	Low	-	Low	Some concerns	Low	Some concerns	Some concerns	Some concerns
Ireland (2017)[30]	Some concerns	-	Low	Some concerns	Low	Low	Some concerns	Some concerns
Mengin (2021)[37]	Some concerns	-	Low	Low	Low	Low	Some concerns	Some concerns
Smith-Coggins (2006)[27]	Low	-	Low	Low	Low	Low	Some concerns	Some concerns

*Note: While Engelmann (2011) and Engelmann (2012) are write-ups of one research study and share some participants (doctor participants), Engelmann (2012) introduces a new group of participants (patients), data and methodology (parallel design) requiring a separate assessment of bias.

Table 2. Risk of Bias in Quasi-experimental studies (ROBINS)

Study	Domain							Overall risk of bias
	Bias due to confounding	Bias in selection of participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported results	
Amin (2012)[26]	Critical	Low	Low	Low	Low	Low	Moderate	Critical
Babbar (2019, 2021)[28, 29]	Critical	Low	Low	Moderate	Low	Serious	Moderate	Critical
Hallbeck (2017)[35]	Moderate	Low	Low	Low	Moderate	Low	Moderate	Moderate
Lemaire (2010)[36]	Moderate	Low	Low	Low	Low	Low	Moderate	Moderate
Mitra (2008)[25]	Serious	Critical	Low	Critical	Serious	Serious	Moderate	Critical
Scheid (2020)[31]	Critical	Low	Low	Serious	Low	Serious	Moderate	Critical

Table 3. Risk of bias in Observational cohort study (JBI)

Study	Q1*	Q2*	Q3	Q4	Q5	Q6*	Q7	Q8	Q9*	Q10*	Q11	% applicable 'yes' answers
Bérastégui (2020)[45]	N/A	N/A	No	No	Yes	N/A	Yes	Yes	Unclear	Unclear	Yes	50.0
Hockey (2020)[46]	N/A	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	100.0
Neprash (2018)[47]	N/A	N/A	Yes	Yes	Yes	N/A	Yes	Yes	N/A	N/A	Yes	100.0
Vosshenrich (2021)[48]	N/A	N/A	No	Yes	No	N/A	Yes	Yes	N/A	N/A	Yes	66.7
% studies scoring 'yes' per question	-	-	50.0	75.0	75.0	-	100.0	100.0	50.0	50.0	100.0	

Q1: Were the two groups similar and recruited from the same population?
Q2: Were the exposures measured similarly to assign people to both exposed and unexposed groups?
Q3: Was the exposure measured in a valid and reliable way?
Q4: Were confounding factors identified?
Q5: Were strategies to deal with confounding factors stated?
Q6: Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?
Q7: Were the outcomes measured in a valid and reliable way?
Q8: Was the follow up time reported and sufficient to be long enough for outcomes to occur?
Q9: Was follow up complete, and if not, were the reasons for loss to follow up described and explored?
Q10: Were strategies to address incomplete follow up utilized?
Q11: Was appropriate statistical analysis used?

*Note: Q1-Q2 not applicable as no included cohort studies included control/comparison groups. Q6 is not applicable as participants were not free of outcome prior to study commencement (e.g. prescribing rates, intensity of positive/negative affect, etc.). Q9-Q10 not applicable to retrospective cohort

studies.

Table 4. Risk of bias in Cross-sectional studies (JBI)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	% 'yes' answers
Al Dandan (2020)[38]	Yes	Yes	No	No	Yes	No	Yes	Yes	62.5
Hassan (2020)[40]	Yes	Yes	No	No	No	No	Yes	Yes	50.0
Kalboussi (2020)[43]	Yes	Yes	Unclear	Unclear	Yes	No	Yes	Unclear	50.0
Kirkcaldy (2002)[41]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.0
Nitszche (2017)[42]	Yes	Yes	No	No	Yes	No	Yes	Yes	62.5
Ohlander (2015)[44]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.0
Winston (2008)[39]	Yes	Yes	Unclear	No	Yes	No	No	Yes	50.0
% studies scoring "yes" per question	100.0	100.0	28.6	28.6	85.7	28.6	85.7	85.7	

Q1: Were the criteria for inclusion in the sample clearly defined?
Q2: Were the study subjects and the setting described in detail?
Q3: Was the exposure measured in a valid and reliable way?
Q4: Were objective, standard criteria used for measurement of the condition?
Q5: Were confounding factors identified?
Q6: Were strategies to deal with confounding factors stated?
Q7: Were the outcomes measured in a valid and reliable way?
Q8: Was appropriate statistical analysis used?

Table 5. Risk of bias in Qualitative studies (JBI)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	% 'yes' answers
Hall (2018)[51]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	90.0
Lemaire (2011)[49]	Unclear	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	80.0
Lockhart (2013)[50]	Unclear	Yes	Yes	Yes	Yes	No	Unclear	Unclear	Unclear	Yes	50.0
Morrow (2014)[52]	Unclear	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	70.0
O'Shea (2020)[53]	Unclear	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	80.0
Walsh (2005)[54]	Unclear	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	70.0
Wilkesmann (2016)[55]	Unclear	Yes	Yes	Yes	Yes	No	No	Unclear	Unclear	Yes	50.0
% studies scoring "yes" per question	14.3	100.0	100.0	100.0	100.0	28.6	14.3	71.4	71.4	100.0	

Q1: Is there congruity between the stated philosophical perspective and the research methodology?
Q2: Is there congruity between the research methodology and the research question or objectives?
Q3: Is there congruity between the research methodology and the methods used to collect data?
Q4: Is there congruity between the research methodology and the representation and analysis of data?
Q5: Is there congruity between the research methodology and the interpretation of results?
Q6: Is there a statement locating the researcher culturally or theoretically?
Q7: Is the influence of the researcher on the research, and vice versa, addressed?
Q8: Are participants and their voices, adequately represented?
Q9: Is the research ethical according to current criteria, for recent studies, and is there evidence of ethical approval by an appropriate body?
Q10: Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?

Using the relevant JBI checklist, observational studies (see table 3) met 62% to 100% of applicable criteria; however, many of the questions posed by the checklists were not applicable due to the design of these studies (two were retrospective) and a lack of control or comparison groups.

Cross-sectional designs (see table 4) met 50% to 100% of the relevant JBI criteria. In the absence of a standardised, objective measure of break taking, it is not surprising that only two of seven (28.6%) studies [41, 44] used standard, valid, objective criteria for measurement of break-taking. In these studies, break duration was measured in minutes where other studies dichotomously asked whether participants took breaks at work ("yes" or "no") or used a non-validated Likert-type scale dividing break frequency or duration into categories. Additionally, these were the only cross-sectional studies that reported appropriate methods to deal with confounding, despite most studies identifying potential confounders.

Qualitative studies (see table 5) met between 50% and 90% of the JBI checklist criteria. Only two of the seven (28.6%) qualitative studies [49, 51] reported the cultural or theoretical position of the researcher, and one study [53] acknowledged the researcher's potential influence on the data.

Discussion

The breadth of break-related topics show that efforts are being made to investigate break effectiveness in doctors. Overall, existing literature suggests a positive effect of break taking on a range of wellbeing and performance outcomes. However, comparison of data is hindered by a lack of consensus about which break-related topics and research questions should be prioritised, how these should be researched and measured, and what defines a break, alongside heterogeneity in the type of study design. Only two included studies investigated the effectiveness of standard 30-minute breaks, [24, 25] which requires particular attention as it is likely the most common type of break taken by doctors at work.

Overall, the quality of studies on break effectiveness was rated as sub-optimal. While sample sizes for survey and cohort studies were moderate, small samples were used in intervention studies and randomised control trials. Additionally, existing experimental (and non-experimental) studies carry a moderate to severe risk of bias due to inherent confounding, a lack of blinding, or control groups. This is problematic as experimental designs would provide the best approximation of break effectiveness and causality.

Qualitative research provides some nuanced understanding of break phenomena, however, existing qualitative literature does not tend to locate researchers culturally, theoretically and philosophically, nor does it acknowledge the potential influence of the researcher on findings.

As a construct, intra-work breaks lack an agreed definition and a standardised means of measurement. There appears to be no consensus on what delineates a break (temporally, contextually or behaviourally), or how to measure it reliably and validly. This lack of agreement further prevents comparisons of data and conclusions about the effectiveness of breaks.

As (to our knowledge) this is the first systematic review of break taking in doctors, we did not place any limits on study design. Whilst this provides a comprehensive review of existing empirical evidence, this review also highlights the substantial variability in types of intervention implemented, measures of outcome used, resulting in a marked heterogeneity of data which makes further quantitative synthesis potentially misleading.

Given the heterogeneity in design, quality, research questions, and outcomes of existing studies, it is not possible to conclude with certainty whether intra-work breaks improve wellbeing and performance in doctors, though the existing evidence suggests a positive trend. This positive effect aligns with existing research in industrial contexts, [18] despite contextual differences between industry and healthcare settings.

To properly understand the effectiveness of breaks for doctors and justify financial and organisational investment in break facilitation, a panoply of policy makers, regulators and research bodies need to agree the priorities so that the evidence base can be developed quickly and effectively. From the results of this systematic review, such priorities need to include: agreed international standardised definitions of intra-work breaks, development of outcome measures of wellbeing for doctors [56]; and consensus on the most robust methodologies to test the effectiveness of intra-work break interventions in real-world situations. There is clearly a need for valid and reliable outcome measures that do not conflate wellbeing with the absence of distress [57], across a range of potential performance outcome measurements, as well as ways of measuring impact on patient care. [58]

The Covid-19 pandemic has highlighted the importance of ensuring workforce well-being, but the evidence of what works best for whom in terms of intra-work breaks remains uncertain.

Contributors: AON: designed the study, collected, analysed and interpreted the data and wrote the first draft of the article. JS overseeing study design, data collection and analysis, edited and approved the final version of the article. DB: funding acquisition, contributed to design of the study and data analysis, and approved the final version of the article. SC contributed to design of the study and data analysis and approved the final version of the article.

Declaration of Competing Interests: DB, JMAS, SC, AoN declare no competing interests

Ethics Statement: As a systematic review of the literature no ethical approval was required.

Funding: Health Education England (HEE) Wessex has provided financial support for a postgraduate student fellowship for 3 years [Ref HEE 19406-01].

Data availability statement: Data are available in a public, open access repository. All data supporting this study are openly available from the University of Southampton repository after thesis submission in May 2022, as the work forms part of a PhD. Supplemental material. This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Figure 1: **PRISMA flow diagram of studies included in the review**

Supplementary material:

References

1. Hummel, S., et al., *Mental health among medical professionals during the COVID-19 pandemic in eight european countries: Cross-sectional survey study.* Journal of medical Internet research, 2021. **23**(1): p. e24983.

2. British Medical Association. *Caring for the Mental Health of Medical Workforce*. [Survey] 2019 October 2019; Available from: https://www.bma.org.uk/advice-and-support/nhs-delivery-and-workforce#workforce.

3. Imo, U.O., *Burnout and psychiatric morbidity among doctors in the UK: a systematic literature review of prevalence and associated factors.* BJPsych bulletin, 2017. **41**(4): p. 197-204.

4. Shanafelt, T.D., et al., *Burnout and self-reported patient care in an internal medicine residency program.* Annals of internal medicine, 2002. **136**(5): p. 358-367.

5. Halbesleben, J.R. and C. Rathert, *Linking physician burnout and patient outcomes: exploring the dyadic relationship between physicians and patients.* Health care management review, 2008. **33**(1): p. 29-39.

6. Shanafelt, T.D., et al., *Burnout and medical errors among American surgeons.* Annals of surgery, 2010. **251**(6): p. 995-1000.

7. West, C.P., et al., *Association of resident fatigue and distress with perceived medical errors.* Jama, 2009. **302**(12): p. 1294-1300.

8. General Medical Council *The state of medical education and practice in the UK*. 2019.

9. Royal College of Anaesthetists. *Respected, valued, retained: Working together to improve retention in anaesthesia*. 2021; Available from: https://www.rcoa.ac.uk/policy-communications/policy-public-affairs/anaesthesia-fit-future/improving-retention-anaesthesia.

10. Patel, R.S., et al., *A review on strategies to manage physician burnout.* Cureus, 2019. **11**(6).

11. Health Education England. *NHS Staff and Learners' Mental Wellbeing Commission*. 2019; Available from: www.hee.nhs.uk.

12. NHS. *WE ARE THE NHS: People Plan for 2020/2021 - action for us all*. 2020; Available from: https://www.england.nhs.uk/ournhspeople/.

13. British Medical Association. *BMA Fatigue and Facilities charter*. 2018; Available from: https://www.bma.org.uk/media/1076/bma-fatigue-and-facilities-charter_july2018.pdf.

14. West, M., & Coia, D. . *Caring for doctors, caring for patients*. 2019; Available from: https://www.gmc-uk.org/-/media/documents/caring-for-doctors-caring-for-patients_pdf-80706341.pdf.

15. NHS England & NHS Improvement. *NHS Health and Wellbeing Framework*. 2018; Available from: https://www.nhsemployers.org/publications/nhs-health-and-wellbeing-framework.

16. Chatfield, C. and A. Rimmer, *Give us a break*. 2019, British Medical Journal Publishing Group.

17. Tomkin, T. *Rest facilities improve for junior doctors*. 2020; Available from: https://www.bma.org.uk/news-and-opinion/rest-facilities-improve-for-junior-doctors.

18. Tucker, P., *The impact of rest breaks upon accident risk, fatigue and performance: a review.* Work & Stress, 2003. **17**(2): p. 123-137.

19. O'Neill A., et al., *The impact of intra-work rest breaks on doctors' performance and wellbeing: A systematic review*, in *PROSPERO*. 2020, PROSPERO: International prospective register of systematic reviews

20. Bramer, W.M., et al., *Optimal database combinations for literature searches in systematic reviews: a prospective exploratory study.* Systematic reviews, 2017. **6**(1): p. 1-12.

21. Sterne, J.A., et al., *RoB 2: a revised tool for assessing risk of bias in randomised trials.* bmj, 2019. **366**.

22. Sterne, J.A., et al., *ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions.* bmj, 2016. **355**.

23. Joanna Briggs Institute. *Critial Appraisal Tools*. 2020; Available from: https://jbi.global/critical-appraisal-tools.

24. Coburn, M., et al., *Influence of a 30-min break on divided attention and working memory in resident anaesthetists on daily routine.* BJA: British Journal of Anaesthesia, 2006. **97**(3): p. 315-319.

25. Mitra, B., et al., *Rest during shift work in the emergency department.* Australian Health Review, 2008. **32**(2): p. 246-251.

26. Amin, M.M., et al., *The effects of a mid-day nap on the neurocognitive performance of first-year medical residents: a controlled interventional pilot study.* Academic Medicine, 2012. **87**(10): p. 1428-1433.

27. Smith-Coggins, R., et al., *Improving alertness and performance in emergency department physicians and nurses: the use of planned naps.* Annals of emergency medicine, 2006. **48**(5): p. 596-604. e3.

28. Babbar, S., K.B. Williams, and A.-L. Cheng, *Sleep among Obstetrics and Gynecology Trainees: Results from a Yoga-Based Wellness Initiative.* American Journal of Perinatology, 2021.

29. Babbar, S., K. Renner, and K. Williams, *Addressing obstetrics and gynecology trainee burnout using a yoga-based wellness initiative during dedicated education time.* Obstetrics & Gynecology, 2019. **133**(5): p. 994-1001.

30. Ireland, M.J., et al., *A randomized controlled trial of mindfulness to reduce stress and burnout among intern medical practitioners.* Medical Teacher, 2017. **39**(4): p. 409-414.

31. Scheid, A., et al., *A yoga-based program decreases physician burnout in neonatologists and obstetricians at an academic medical center.* Workplace Health & Safety, 2020. **68**(12): p. 560-566.

32. Dorion, D. and S. Darveau, *Do micropauses prevent surgeon's fatigue and loss of accuracy associated with prolonged surgery? An experimental prospective study.* Journal of Vascular Surgery, 2013. **57**(4): p. 1173.

33. Engelmann, C., et al., *Effects of intraoperative breaks on mental and somatic operator fatigue: a randomized clinical trial.* Surgical endoscopy, 2011. **25**(4): p. 1245-1250.

34. Engelmann, C., et al., *Work breaks during minimally invasive surgery in children: patient benefits and surgeon's perceptions.* European journal of pediatric surgery, 2012. **22**(06): p. 439-444.

35. Hallbeck, M., et al., *The impact of intraoperative microbreaks with exercises on surgeons: a multi-center cohort study.* Applied ergonomics, 2017. **60**: p. 334-341.

36. Lemaire, J.B., et al., *Physician nutrition and cognition during work hours: effect of a nutrition based intervention.* BMC health services research, 2010. **10**(1): p. 1-9.

37. Mengin, A.C., et al., *Mindfulness Improves Otolaryngology Residents' Performance in a Simulated Bad-News Consultation: A Pilot Study.* Journal of Surgical Education, 2021. **78**(4): p. 1357-1365.

38. Al Dandan, O., et al., *Digital eye strain among radiologists: A survey-based cross-sectional study.* Academic Radiology, 2021. **28**(8): p. 1142-1148.

39. Winston, J., C. Johnson, and S. Wilson, *Barriers to healthy eating by National Health Service (NHS) hospital doctors in the hospital setting: results of a cross-sectional survey.* BMC research notes, 2008. **1**(1): p. 1-7.

40. Hassan, N.M., et al., *Job stress among resident physicians in Tanta University Hospitals, Egypt.* Environmental Science and Pollution Research, 2020. **27**(30): p. 37557-37564.

41. Kirkcaldy, B., R. Trimpop, and R. Levine, *The impact of work hours and schedules on the physical and psychological well-being in medical practices.* European Psychologist, 2002. **7**(2): p. 116.

42. Nitzsche, A., et al., *Recovery opportunities, work–home conflict, and emotional exhaustion among hematologists and oncologists in private practice.* Psychology, health & medicine, 2017. **22**(4): p. 462-473.

43. Kalboussi, H., et al. *Burnout Syndrome and its associated factors among Anesthesia Technicians in a Teaching Hospital in the central region of Tunisia*. in *Annales Medico-Psychologiques*. 2020. Masson Editeur, France.

44. Ohlander, J., et al., *Working conditions and effort–reward imbalance of German physicians in Sweden respective Germany: a comparative study.* International archives of occupational and environmental health, 2015. **88**(4): p. 511-519.

45. Bérastégui, P., et al., *Informal fatigue-related risk management in the emergency department: a trade-off between doing well and feeling well.* Safety science, 2020. **122**: p. 104508.

46. Hockey, P., et al., *Measuring the working experience of doctors in training.* Future Healthcare Journal, 2020. **7**(3): p. e17.

47. Neprash, H. and Barnett M.L., *Cognitive fatigue and opioid prescribing: Evidence from prescribing over the day and week.* Journal of General Internal Medicine, 2018. **33**(2, Suppl. 1, S142.).

48. Vosshenrich, J., et al., *Quantifying Radiology Resident Fatigue: Analysis of Preliminary Reports.* Radiology, 2021. **298**(3): p. 632-639.

49. Lemaire, J.B., et al., *Food for thought: an exploratory study of how physicians experience poor workplace nutrition.* Nutrition Journal, 2011. **10**(1): p. 1-8.

50. Lockhart, S., S. Jamal, and K. Shojania, *Regular Physical Exercise Incorporated into a Rheumatology Fellowship Curriculum: A Qualitative Survey of Participants.* Journal of Rheumatology, 2013. **40**(6): p. 1014-1014.

51. Hall, L.H., et al., *Strategies to improve general practitioner well-being: findings from a focus group study.* Family practice, 2018. **35**(4): p. 511-516.

52. Morrow, G., et al., *Have restricted working hours reduced junior doctors' experience of fatigue? A focus group and telephone interview study.* BMJ open, 2014. **4**(3): p. e004222.

53. O'Shea, J., et al., *"Breaking" the Emergency Department: Does the Culture of Emergency Medicine Present a Barrier to Self-Care?* Western Journal of Emergency Medicine, 2020. **21**(2): p. 313.

54. Walsh, A., et al., *Motherhood during residency training: challenges and strategies.* Canadian Family Physician, 2005. **51**(7): p. 990-991.

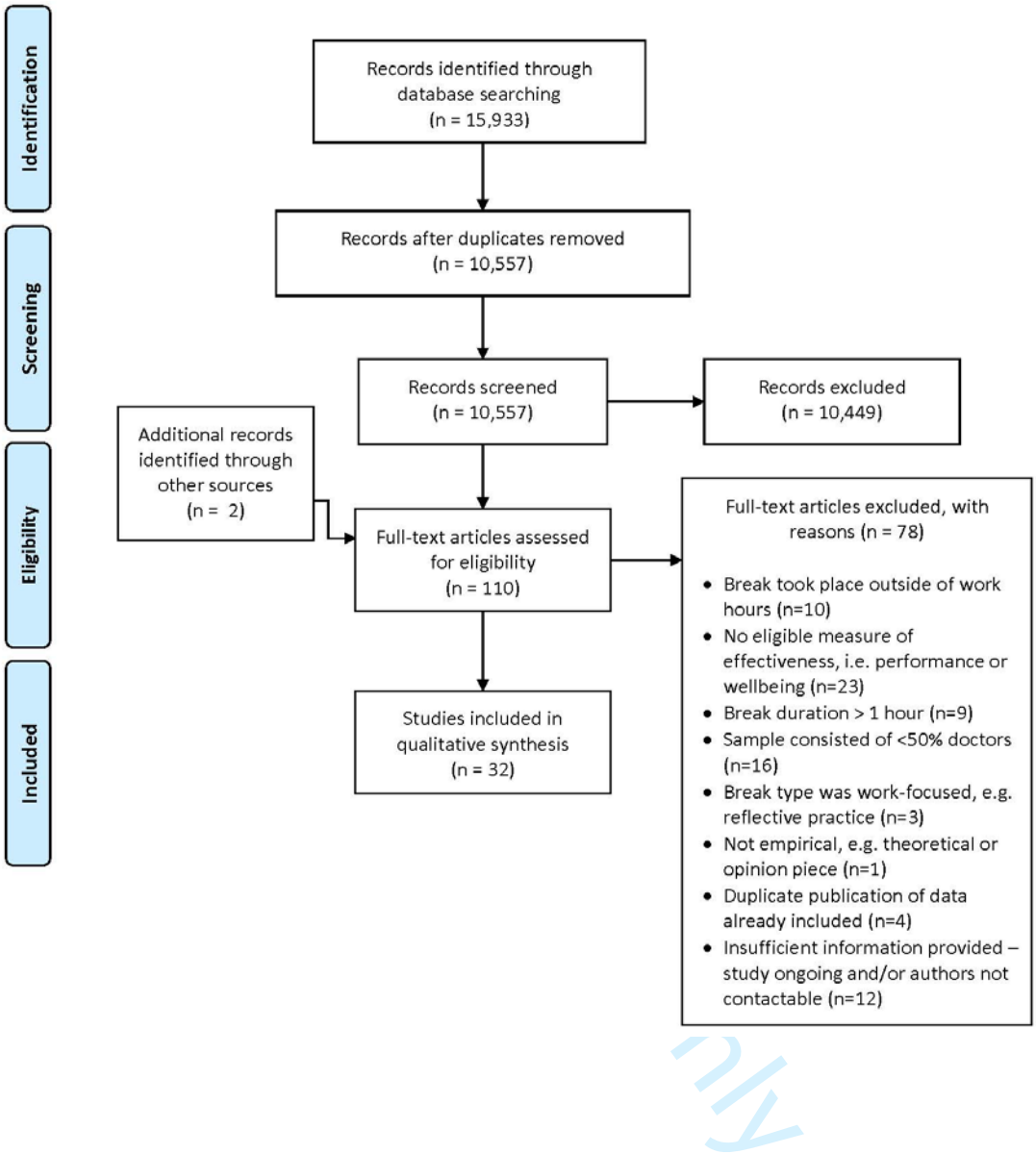
55. Wilkesmann, M., *Ignorance management in hospitals.* VINE Journal of Information and Knowledge Management Systems, 2016. **46**(4): p. 430-449.

56. Simons, G. and D.S. Baldwin, *A critical review of the definition of 'wellbeing'for doctors and their patients in a post Covid-19 era.* International Journal of Social Psychiatry, 2021. **67**(8): p. 984-991.

57. Brady, K.J., et al., *What do we mean by physician wellness? A systematic review of its definition and measurement.* Academic Psychiatry, 2018. **42**(1): p. 94-108.

58. Dyrbye, L.N., et al., *A pragmatic approach for organizations to measure health care professional well-being.* NAM Perspectives, 2018.

Figure 1 PRISMA flow diagram of studies included in the review



Based on: 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(7): e1000097. doi:10.1371/journal.pmed1000097

Supplementary material: Contents:

Supplementary material: Abbreviations

N.S	Not significant/not significantly/non-significant
EEG	Electroencephalogram
BS	Before shift
PI	Post intervention
AS	After shift
IV	Intravenous
ED	Emergency department
EM	Emergency medicine
IM	Internal medicine
M/F	Male/Female
ENT	Ear nose and throat
GP	General Practitioner
No.	Number

Supplementary material: Search strategy

Ovid Embase Classic + Embase 1947 – 2021 June 06

1	exp physician/ OR exp resident/
2	(doctor* OR physician* OR resident*).ab,ti
3	#1 OR #2
4	exp rest/
5	(break OR breakroom OR breaks OR break-time OR break-taking OR doctors mess OR micro-break* OR microbreak* OR nap OR napping OR naps OR rest OR rest-break* OR restful OR resting OR sleep OR sleeping OR work-break*).ab,ti
6	#4 OR #5
7	exp "occupation and occupation related phenomena"/
8	(duty OR duties OR employee* OR employment OR internship* OR job OR jobs OR occupation* OR on-call OR on-shift OR organisation* OR organization* OR profession* OR rotation* OR rota* OR shift OR shifts OR shift-work OR shift-working OR staff OR work OR workday* OR work environment* OR worker* OR workforce OR working OR workload OR workplace OR work-related).ab,ti
9	#7 OR #8
10	#3 AND #6 AND #9
11	exp health/ OR exp wellbeing/ OR exp occupational health/ OR exp medical error/ OR exp work/ OR exp occupational science/
12	(absenteeism OR anxiety OR anxious OR burnout OR depression OR depressive OR employee health OR exhaustion OR fatigue OR mental health OR musculoskeletal OR occupational health OR occupational disease* OR occupational injury OR occupational injuries OR presenteeism OR quality of life OR recovery OR resilience OR resiliency OR sick note* OR sickness absence* OR sickness leave OR sick leave OR sleepiness OR staff absence* OR staff leave OR stress OR tiredness OR turnover OR wakefulness OR well-being OR wellbeing OR well being OR wellness OR well-ness OR work absence*).ab,ti
13	(ability to concentrate OR adverse event* OR alertness OR appraisal* OR assess* performance OR care quality OR claim* by patient* OR care of patient* OR care for patient* OR clinical performance OR clinical outcome* OR competen* at work OR concentration OR consultation satisfaction OR deadline* OR death rate* OR feedback OR fit* to practice OR fit* to practise OR decision-making OR decision making OR industrial safety OR industrial health OR infection rate* OR job dedication OR job effectiveness OR job efficiency OR job engagement OR job motivation OR job performance OR job satisfaction OR job skill* OR job productivity OR medical error* OR medical mistake* OR medical negligenc* OR meet* objective* OR mental acuity OR occupational safety OR organisational citizenship OR organizational citizenship OR patient care OR patient complaint* OR patient claim* OR patient death* OR patient outcome* OR patient mortality OR patient satisfaction OR patient wait* time* OR perform task* OR performance assess* OR prevention uptake rate* OR quality of work OR quality of care OR quality indicat* OR quality of service OR reaction speed* OR reaction time* OR readmission* rate* OR referral rate* OR revalidation OR service provision OR significant event* OR standard* of care OR surgery rate* OR target* OR task performance OR teamwork OR treatment outcome* OR wait* list* OR wait* time* OR work capacity OR working effectively OR working efficiently OR work engagement OR work performance OR work productivity OR work quality).ab,ti
14	("friends and family test*").ab,ti
15	#11 OR #12 OR #13 OR #14

16	#10 AND #15

PubMed

1	physician [MeSH] OR “Internship and Residency”[MeSH]
2	doctor*[Title/Abstract] OR physician*[Title/Abstract] OR resident* [Title/Abstract]
3	#1 OR #2
4	"rest"[MeSH]
5	break[Title/Abstract] OR breakroom[Title/Abstract] OR breaks OR breaktime[Title/Abstract] OR break-taking[Title/Abstract] OR “doctors mess”[Title/Abstract] OR “doctor’s mess”[Title/Abstract] OR micro-break*[Title/Abstract] OR microbreak*[Title/Abstract] OR nap[Title/Abstract] OR napping[Title/Abstract] OR naps[Title/Abstract] OR rest[Title/Abstract] OR rest-break*[Title/Abstract] OR restful[Title/Abstract] OR resting[Title/Abstract] OR sleep[Title/Abstract] OR sleeping[Title/Abstract] OR work-break*[Title/Abstract]
6	#4 OR #5
7	work[MeSH] OR workplace[MeSH]
8	duty[Title/Abstract] OR duties[Title/Abstract] OR employee*[Title/Abstract] OR employment[Title/Abstract] OR internship*[Title/Abstract] OR job[Title/Abstract] OR jobs[Title/Abstract] OR occupation*[Title/Abstract] OR on-call[Title/Abstract] OR on-shift[Title/Abstract] OR organisation*[Title/Abstract] OR organization*[Title/Abstract] OR profession*[Title/Abstract] OR rotation*[Title/Abstract] OR rota*[Title/Abstract] OR shift[Title/Abstract] OR shifts[Title/Abstract] OR shift-work[Title/Abstract] OR shift-working[Title/Abstract] OR staff[Title/Abstract] OR work[Title/Abstract] OR workday*[Title/Abstract] OR “work environment*”[Title/Abstract] OR worker* OR workforce[Title/Abstract] OR working[Title/Abstract] OR workload[Title/Abstract] OR workplace[Title/Abstract] OR work-related[Title/Abstract]
9	#7 OR #8
10	#3 AND #6 AND #9
11	“occupational health”[MeSH] OR “mental health”[MeSH] OR “medical errors”[MeSH] OR “work performance”[MeSH]
12	absenteeism[Title/Abstract] OR anxiety[Title/Abstract] OR anxious[Title/Abstract] OR burnout[Title/Abstract] OR depression[Title/Abstract] OR depressive[Title/Abstract] OR employee health[Title/Abstract] OR exhaustion[Title/Abstract] OR fatigue[Title/Abstract] OR mental health[Title/Abstract] OR musculoskeletal[Title/Abstract] OR occupational health[Title/Abstract] OR occupational disease*[Title/Abstract] OR occupational injury[Title/Abstract] OR occupational injuries[Title/Abstract] OR presenteeism[Title/Abstract] OR quality of life[Title/Abstract] OR recovery[Title/Abstract] OR resilience[Title/Abstract] OR resiliency[Title/Abstract] OR sick note*[Title/Abstract] OR sickness absence*[Title/Abstract] OR sickness leave[Title/Abstract] OR sick leave[Title/Abstract] OR sleepiness[Title/Abstract] OR staff absence*[Title/Abstract] OR staff leave[Title/Abstract] OR stress[Title/Abstract] OR tiredness[Title/Abstract] OR turnover[Title/Abstract] OR wakefulness[Title/Abstract] OR well-being[Title/Abstract] OR wellbeing[Title/Abstract] OR well being[Title/Abstract] OR wellness[Title/Abstract] OR well-ness[Title/Abstract] OR work absence*[Title/Abstract]
13	ability to concentrate[Title/Abstract] OR adverse event*[Title/Abstract] OR alertness[Title/Abstract] OR appraisal*[Title/Abstract] OR assess* performance[Title/Abstract] OR care quality[Title/Abstract] OR claim* by patient*[Title/Abstract] OR care of patient*[Title/Abstract] OR care for patient*[Title/Abstract] OR clinical performance[Title/Abstract] OR clinical outcome*[Title/Abstract] OR competen* at work[Title/Abstract] OR concentration[Title/Abstract] OR consultation satisfaction[Title/Abstract] OR deadline*[Title/Abstract] OR death rate*[Title/Abstract] OR feedback[Title/Abstract] OR fit* to practice[Title/Abstract] OR fit* to practise[Title/Abstract] OR decision-making[Title/Abstract] OR decision making[Title/Abstract] OR industrial safety[Title/Abstract] OR industrial health[Title/Abstract] OR infection rate*[Title/Abstract] OR job

	dedication[Title/Abstract] OR job effectiveness[Title/Abstract] OR job efficiency[Title/Abstract] OR job engagement[Title/Abstract] OR job motivation[Title/Abstract] OR job performance[Title/Abstract] OR job satisfaction[Title/Abstract] OR job skill*[Title/Abstract] OR job productivity[Title/Abstract] OR medical error*[Title/Abstract] OR medical mistake*[Title/Abstract] OR medical negligenc*[Title/Abstract] OR meet* objective*[Title/Abstract] OR mental acuity[Title/Abstract] OR occupational safety[Title/Abstract] OR organisational citizenship[Title/Abstract] OR organizational citizenship[Title/Abstract] OR patient care[Title/Abstract] OR patient complaint*[Title/Abstract] OR patient claim*[Title/Abstract] OR patient death*[Title/Abstract] OR patient outcome*[Title/Abstract] OR patient mortality[Title/Abstract] OR patient satisfaction[Title/Abstract] OR patient wait* time*[Title/Abstract] OR perform task*[Title/Abstract] OR performance assess*[Title/Abstract] OR prevention uptake rate*[Title/Abstract] OR quality of work[Title/Abstract] OR quality of care[Title/Abstract] OR quality indicat*[Title/Abstract] OR quality of service[Title/Abstract] OR reaction speed*[Title/Abstract] OR reaction time*[Title/Abstract] OR readmission* rate*[Title/Abstract] OR referral rate*[Title/Abstract] OR revalidation[Title/Abstract] OR service provision[Title/Abstract] OR significant event*[Title/Abstract] OR standard* of care[Title/Abstract] OR surgery rate*[Title/Abstract] OR target*[Title/Abstract] OR task performance[Title/Abstract] OR teamwork[Title/Abstract] OR treatment outcome*[Title/Abstract] OR wait* list*[Title/Abstract] OR wait* time*[Title/Abstract] OR work capacity[Title/Abstract] OR working effectively[Title/Abstract] OR working efficiently[Title/Abstract] OR work engagement[Title/Abstract] OR work performance[Title/Abstract] OR work productivity[Title/Abstract] OR work quality[Title/Abstract] OR “friends and family test*”[Title/Abstract]
14	#11 OR #12 OR #13
15	#10 AND #14

Web of Science

	(Topic search selected)
1	doctor* OR physician* OR resident*
2	break OR breakroom OR breaks OR “break-time” OR “break-taking” OR “doctors mess” OR “micro-break*” OR microbreak* OR nap OR napping OR naps OR rest OR “rest-break*” OR restful OR resting OR sleep OR sleeping OR “work-break*”
3	duty OR duties OR employee* OR employment OR internship* OR job OR jobs OR occupation* OR “on-call” OR “on-shift” OR organisation* OR organization* OR profession* OR rotation* OR rota* OR shift OR shifts OR “shift-work” OR “shift-working” OR staff OR work OR workday* OR “work environment*” OR worker* OR workforce OR working OR workload OR workplace OR “work-related”
4	#1 AND #2 AND #3 = 5,854
5	#5 absenteeism OR anxiety OR anxious OR burnout OR depression OR depressive OR “employee health” OR exhaustion OR fatigue OR “mental health” OR musculoskeletal OR “occupational health” OR “occupational disease*” OR “occupational injury” OR “occupational injuries” OR presenteeism OR “quality of life” OR recovery OR resilience OR resiliency OR “sick note*” OR “sickness absence*” OR “sickness leave” OR “sick leave” OR sleepiness OR “staff absence*” OR “staff leave” OR stress OR tiredness OR turnover OR wakefulness OR “well-being” OR wellbeing OR “well being” OR wellness OR “well-ness” OR “work absence*”
6	“ability to concentrate” OR “adverse event*” OR alertness OR appraisal* OR “assess* performance” OR “care quality” OR “claim* by patient*” OR “care of patient*” OR “care for patient*” OR “clinical performance” OR “clinical outcome*” OR “competen* at work” OR concentration OR “consultation satisfaction” OR deadline* OR “death rate*” OR “decision-making” OR “decision making” OR feedback OR “fit* to practice” OR “fit* to practise” OR “friends and family test*” OR “industrial safety” OR “industrial health” OR “infection rate*” OR “job dedication” OR “job effectiveness” OR “job efficiency” OR “job engagement” OR “job motivation” OR “job performance” OR “job satisfaction” OR “job skill*” OR “job productivity” OR “medical error*” OR “medical mistake*” OR “medical negligenc*” OR “meet* objective*” OR “mental acuity” OR “occupational safety” OR

	“organisational citizenship” OR “organizational citizenship” OR “patient care” OR “patient complaint*” OR “patient claim*” OR “patient death*” OR “patient outcome*” OR “patient mortality” OR “patient satisfaction” OR “patient wait* time*” OR “perform task*” OR “performance assess*” OR “prevention uptake rate*” OR “quality of work” OR “quality of care” OR “quality indicat*” OR “quality of service” OR “reaction speed*” OR “reaction time*” OR “readmission* rate*” OR “referral rate*” OR revalidation OR “service provision” OR “significant event*” OR “standard* of care” OR “surgery rate*” OR target* OR “task performance” OR teamwork OR “treatment outcome*” OR “wait* list*” OR “wait* time*” OR “work capacity” OR “working effectively” OR “working efficiently” OR “work engagement” OR “work performance” OR “work productivity” OR “work quality”
7	#5 OR #6
8	#4 AND #7

PsycINFO

1	DE "Physicians" OR DE "Family Physicians" OR DE "General Practitioners" OR DE "Gynecologists" OR DE "Internists" OR DE "Neurologists" OR DE "Obstetricians" OR DE "Pathologists" OR DE "Pediatricians" OR DE "Psychiatrists" OR DE "Surgeons" OR DE “medical residency” OR DE “medical internship”
2	TI doctor* OR TI physician* OR AB doctor* OR AB physician* OR TI resident* OR AB resident*
3	S1 OR S2
4	DE "Relaxation" OR DE "Work Rest Cycles"
5	TI break OR TI breakroom OR TI breaks OR TI “break-time” OR TI “break-taking” OR TI “doctors mess” OR TI “micro-break*” OR TI microbreak* OR TI nap OR TI napping OR TI naps OR TI rest OR TI “rest-break*” OR TI restful OR TI resting OR TI sleep OR TI sleeping OR TI “work-break*” OR AB break OR AB breakroom OR AB breaks OR AB “break-time” OR AB “break-taking” OR AB “doctors mess” OR AB “micro-break*” OR AB microbreak* OR AB nap OR AB napping OR AB naps OR AB rest OR AB “rest-break*” OR AB restful OR AB resting OR AB sleep OR AB sleeping OR AB “work-break*”
6	S4 OR S5
7	#DE "Working Conditions" OR "Workday Shifts" OR DE "Working Space"
8	TI duty OR TI duties OR TI employee* OR TI employment OR TI internship* OR TI job OR TI jobs OR TI occupation* OR TI “on-call” OR TI “on-shift” OR TI organisation* OR TI organization* OR TI profession* OR TI rotation* OR TI rota* OR TI shift OR TI shifts OR TI “shift-work” OR TI “shift-working” OR TI staff OR TI work OR TI workday* OR TI “work environment*” OR TI worker* OR TI workforce OR TI working OR TI workload OR TI workplace OR TI “work-related” OR AB duty OR AB duties OR AB employee* OR AB employment OR AB internship* OR AB job OR AB jobs OR AB occupation* OR AB “on-call” OR AB “on-shift” OR AB organisation* OR AB organization* OR AB profession* OR AB rotation* OR AB rota* OR AB shift OR AB shifts OR AB “shift-work” OR AB “shift-working” OR AB staff OR AB work OR AB workday* OR AB “work environment*” OR AB worker* OR AB workforce OR AB working OR AB workload OR AB workplace OR AB “work-related”
9	S7 OR S8
10	S3 AND S6 AND S9 = 1,702
11	DE "Health Status" OR DE "Health Literacy" OR DE "Health Outcomes" OR DE "Mental Health" OR DE "Occupational Health" OR DE "Physical Health" OR DE "Well Being" OR DE "Spiritual Well Being" OR DE "Errors" OR DE "Patient Safety" OR DE "Job Performance" OR DE "Employee Efficiency" OR DE "Employee Productivity" OR DE "Job Satisfaction"
12	TI absenteeism OR TI anxiety OR TI anxious OR TI burnout OR TI depression OR TI depressive OR TI “employee health” OR TI exhaustion OR TI fatigue OR TI “mental health” OR TI musculoskeletal OR TI “occupational health” OR TI “occupational disease*” OR TI “occupational injury” OR TI “occupational injuries” OR TI presenteeism OR TI “quality of life” OR TI recovery OR TI resilience OR TI resiliency OR TI “sick note*” OR TI “sickness absence*” OR TI “sickness leave” OR TI “sick leave” OR TI sleepiness OR TI “staff absence*” OR TI “staff leave” OR TI stress OR TI tiredness OR TI turnover OR TI

	wakefulness OR TI "well-being" OR TI wellbeing OR TI "well being" OR TI wellness OR TI "well-ness" OR TI "work absence*" OR AB absenteeism OR AB anxiety OR AB anxious OR AB burnout OR AB depression OR AB depressive OR AB "employee health" OR AB exhaustion OR AB fatigue OR AB "mental health" OR AB musculoskeletal OR AB "occupational health" OR AB "occupational disease*" OR AB "occupational injury" OR AB "occupational injuries" OR AB presenteeism OR AB "quality of life" OR AB recovery OR AB resilience OR AB resiliency OR AB "sick note*" OR AB "sickness absence*" OR AB "sickness leave" OR AB "sick leave" OR AB sleepiness OR AB "staff absence*" OR AB "staff leave" OR AB stress OR AB tiredness OR AB turnover OR AB wakefulness OR AB "well-being" OR AB wellbeing OR AB "well being" OR AB wellness OR AB "well-ness" OR AB "work absence*"
13	TI "ability to concentrate" OR TI "adverse event*" OR TI alertness OR TI appraisal* OR TI "assess* performance" OR TI "care quality" OR TI "claim* by patient*" OR TI "care of patient*" OR TI "care for patient*" OR TI "clinical performance" OR TI "clinical outcome*" OR TI "competen* at work" OR TI concentration OR TI "consultation satisfaction" OR TI deadline* OR TI "death rate*" OR TI "decision-making" OR TI "decision making" OR TI feedback OR TI "fit* to practice" OR TI "fit* to practise" OR TI "friends and family test*" OR TI "industrial safety" OR TI "industrial health" OR TI "infection rate*" OR TI "job dedication" OR TI "job effectiveness" OR TI "job efficiency" OR TI "job engagement" OR TI "job motivation" OR TI "job performance" OR TI "job satisfaction" OR TI "job skill*" OR TI "job productivity" OR TI "medical error*" OR TI "medical mistake*" OR TI "medical negligenc*" OR TI "meet* objective*" OR TI "mental acuity" OR TI "occupational safety" OR TI "organisational citizenship" OR TI "organizational citizenship" OR TI "patient care" OR TI "patient complaint*" OR TI "patient claim*" OR TI "patient death*" OR TI "patient outcome*" OR TI "patient mortality" OR TI "patient satisfaction" OR TI "patient wait* time*" OR TI "perform task*" OR TI "performance assess*" OR TI "prevention uptake rate*" OR TI "quality of work" OR TI "quality of care" OR TI "quality indicat*" OR TI "quality of service" OR TI "reaction speed*" OR TI "reaction time*" OR TI "readmission* rate*" OR TI "referral rate*" OR TI revalidation OR TI "service provision" OR TI "significant event*" OR TI "standard* of care" OR TI "surgery rate*" OR TI target* OR TI "task performance" OR TI teamwork OR TI "treatment outcome*" OR TI "wait* list*" OR TI "wait* time*" OR TI "work capacity" OR TI "work* effectively" OR TI "work* efficiently" OR TI "work engagement" OR TI "work performance" OR TI "work productivity" OR TI "work quality" OR AB "ability to concentrate" OR AB "adverse event*" OR AB alertness OR AB appraisal* OR AB "assess* performance" OR AB "care quality" OR AB "claim* by patient*" OR AB "care of patient*" OR AB "care for patient*" OR AB "clinical performance" OR AB "clinical outcome*" OR AB "competen* at work" OR AB concentration OR AB "consultation satisfaction" OR AB deadline* OR AB "death rate*" OR AB "decision-making" OR AB "decision making" OR AB feedback OR AB "fit* to practice" OR AB "fit* to practise" OR AB "friends and family test*" OR AB "industrial safety" OR AB "industrial health" OR AB "infection rate*" OR AB "job dedication" OR AB "job effectiveness" OR AB "job efficiency" OR AB "job engagement" OR AB "job motivation" OR AB "job performance" OR AB "job satisfaction" OR AB "job skill*" OR AB "job productivity" OR AB "medical error*" OR AB "medical mistake*" OR AB "medical negligenc*" OR AB "meet* objective*" OR AB "mental acuity" OR AB "occupational safety" OR AB "organisational citizenship" OR AB "organizational citizenship" OR AB "patient care" OR AB "patient complaint*" OR AB "patient claim*" OR AB "patient death*" OR AB "patient outcome*" OR AB "patient mortality" OR AB "patient satisfaction" OR AB "patient wait* time*" OR AB "perform task*" OR AB "performance assess*" OR AB "prevention uptake rate*" OR AB "quality of work" OR AB "quality of care" OR AB "quality indicat*" OR AB "quality of service" OR AB "reaction speed*" OR AB "reaction time*" OR AB "readmission* rate*" OR AB "referral rate*" OR AB revalidation OR AB "service provision" OR AB "significant event*" OR AB "standard* of care" OR AB "surgery rate*" OR AB target* OR AB "task performance" OR AB teamwork OR AB "treatment outcome*" OR AB "wait* list*" OR AB "wait* time*" OR AB "work capacity" OR AB "work* effectively" OR AB "work* efficiently" OR AB "work engagement" OR AB "work performance" OR AB "work productivity" OR AB "work quality"
14	#11 OR #12 OR #13
15	#10 AND #14

Availability of all data collection forms, data extracted from included studies hosted on University of Southampton Website, and available on request

Supplementary Table 1: Summary of Included Studies

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
QUANTITATIVE STUDIES					
Standard 30-min break interventions					
Coburn (2006)[24] Germany Published report	Double blind randomised cross-over trial. Min. 28 days between phases	N=30 anaesthesia trainee doctors; 63.3% M	30-min breaks in a recreation room vs no break during 7.5 hr shifts	*Measured at 7:30 and 14:00:* 1) Test for Attentional Performance 2) Stanford Sleepiness Scale 3) State-Trait Anxiety Inventory	N.S difference between break or control on divided attention, working memory, sleepiness or self-reported anxiety
Mitra (2008) [25] Australia Published report	Before-and-after study over 4-week period (2-wk baseline phase, 2-wk intervention phase)	N=121 baseline and N=112 post-intervention surveys from ED doctors of all grades; M/F ratio not reported	Baseline/usual practice phase vs promotion of 30-min uninterrupted breaks (facilitated by cover doctor, educational sessions and posters)	*Completed at the end of every shift:* 1) Number of breaks and duration 2) Visual analogue tiredness rating 3) Fatigue Severity Scale 4) Routine departmental performance indicators	1) Break-taking improved from 33% to 60% 2) Subjective tiredness at end of shift lower when break taken (p<.001) 3) Reduction in objective fatigue levels at end of shift when break taken (p=.065) 4) Departmental performance indicators (e.g. triage time, time to be seen) improved (p<.001)
Sleep-related interventions					
Amin (2012) [26] USA Published report	Cluster non-randomised controlled trial. Single-day protocol. Intervention and control 1 yr apart	N=29 1st year medicine trainees; n=19 intervention, n=11 control; 58.6% M	20-min midday naps in a recliner chair during daytime shifts vs controls who lay in chair but conversed with researcher for 20 min	*Measured before and after intervention:* 1) Conner's Continuous Performance Test (CPTII) 2) Attentional failures (EEG) 3) Average sleep duration during intervention	1) Cognitive functioning improved in nap group compared with control (Hit reaction time p=.004; Omission rate p=.01; Commission rate p=.007) 2) Attentional failures decreased in nap group and increased in control group (p=.002) 3) 8.4 +/- 3 mins
Smith-Coggins (2006) [27] USA Published report	RCT. 2-day protocol: baseline shift and shift with intervention	N=49 ED staff (n=25 doctors, n=24 nurses); n=26 intervention, n=23 control; 32.7% M	40-min nap opportunity at 3AM during a 12-hr night shift vs continued work	*Measured before shift (BS-6:30pm), post-intervention (PI-4am) and after shift (AS-7:30am) on baseline and intervention day:* 1) Psychomotor Vigilance Task 2) Probe Recall Memory Task 3) IV simulation (CathSim) 4) Profile of Mood States 5) Karolinska Sleepiness Scale	1) No differences except AS-7:30am: Nap group had fewer lapses (p<.03) and faster reaction time (p<.05) 2) No differences except PI-4am when nap group worsened after nap (p<.05) 3) BS-6:30pm Control group quicker (p<.04), AS-7:30am nap group N.S. quicker (p=0.10) 4) AS-7:30am nap group had less fatigue (p<.05) and more vigor (p<.03) 5) AS-7:30am Less sleepiness (p<.03) in nap group

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
				6) Driving simulation (StiSim Drive Simulation System) *Measured during nap (3am):* 7) Polysomnographic data	6) Nap group improved dangerous driving and alertness from baseline, control group worsened from baseline (p<.03). No aggregate group differences on intervention day. 7) Average nap time: 24.8 mins (SD=11.1) Average sleep onset: 8.9 mins (SD=5.5)
Yoga and mindfulness interventions					
Babbar (2019) [29] USA Published report	Before-and-after study conducted over 8-week period	N=25 OBGYN trainee doctors and maternal-fetal medicine fellows; M/F ratio not reported	Weekly 1-hr yoga sessions held within protected education time	*Measured before and after 8-week intervention:* 1) Maslach Burnout Inventory 2) Depression Anxiety Stress Scale 3) Five Facet Mindfulness Questionnaire 4) Blood pressure (BP) 5) Heart rate 6) Average weight 7) Feedback survey on program	1) Reduction in depersonalization domain (p=.04). N.S. difference in other 2 domains. 2) Anxiety rates reduced (40% to 28%), stress rates reduced (40% to 24%), no difference in depression. 3) 1/5 domains increased (p=.01). N.S difference in total mindfulness. N.S difference between frequent and infrequent yoga attendees. 4) Systolic and diastolic BP decreased (p=.01). Greater decrease in frequent attendees (p=.04) 5) N.S difference. 6) Increased (p=.03). 7) 74% agreed protected wellness with colleagues improved training experience and felt more appreciated. 83% felt increased sense of camaraderie and more motivated to incorporate wellness in their lives. 90% became more aware of physical activity.
Babbar (2021) [28]* USA Published report *Note: Follow-up to Babbar 2019[23]	Before-and-after study conducted over 8-wk period	N=13 OBGYN trainee doctors and maternal-fetal medicine fellows; M/F ratio not reported	Weekly 1-hr yoga sessions held within protected education time	1) Daily objective sleep data (Polar A370 fitness tracker) 2) Baseline and post-intervention subjective sleep data (Pittsburgh Sleep Quality Index)	1) On yoga days, attendees had greater total (p = 0.04) and restful sleep (p=0.01) than non-attendees. Compared with non-yoga days, attendees had greater total (p=0.05) and restful sleep (p = 0.04) the night following yoga class. 2) N.S changes
Ireland (2017) [30] Australia Published report	RCT conducted over 10-week period	N=44 EM trainees n=23 intervention, n=21 control; 36% M	Wkly 1-hr mindfulness sessions for 10 wks vs 1-hr midday break per wk	*Measured at beginning (week1), middle (week 5), and end (week 10) of intervention:* 1) Perceived Stress Scale 2) Copenhagen Burnout Inventory	1) Intervention group stress decreased over time (p=.007, η^2=0.28). Control group stress N.S increased over time (p=0.302, η^2=0.08). 2) Intervention group burnout N.S improved over time (p=.072, η^2=0.16); Control group burnout N.S. increased over time (p=0.222; η^2=0.10)

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Scheid (2020) [31] USA Published report	Before-and-after study (6-wk intervention period)	N=12 faculty physicians; 0% M	Baseline/usual practice vs weekly 1-hr yoga sessions for 6 wks during work hrs	*Measured at baseline, post-intervention and 2 months post-intervention:* 1) Professional fulfilment and burnout (Professional Fulfilment Index); 2) Perceived Stress Scale 3) Resilience Scale; 4) Anxiety, depression and sleep disturbances (Patient-Reported Outcomes Measurement Information System) 5) Positive and Negative Affect Schedule; 6) Five Facet Mindfulness Questionnaire	*Between baseline and post-intervention:* Significant improvements in perceived stress (p=.031), anxiety (p=.045), depression (p=.029), resilience (p=.005), professional fulfilment (p=.031) and burnout (p=.047). N.S change in sleep disturbances, affect and mindfulness. *Between baseline and 2-month follow-up:* Significant improvement in 1 dimension of burnout (p=.038), resilience (p=.024), and mindfulness (p=.012. N.S change in professional fulfilment, overall burnout, perceived stress, anxiety, depression, sleep disturbances and affect.
Microbreak interventions in surgery					
Dorion (2013) [32] Canada Published report	Randomised crossover trial (N=16)	N=16 surgical staff and trainees; M/F ratio not reported	Control vs 20-second micropauses every 20 mins during prolonged (2 hr minimum) surgery	*Rated after control and intervention surgery:* 1) Study-specific rating of physical discomfort; 2) Fatigue (2.5kg weight hold for as long as possible) 3) Star-shaped precision test	1) Micropauses improved discomfort in neck, back, shoulders, wrists, elbows and eyes compared with control (p<.05). N.S difference in legs/lower limbs. 2) Micropauses improved muscular fatigue cf. control (p<.001). 3) Micropauses improved accuracy cf. control (p<0.01).
Engelmann (2011) [33] Germany Published report	Randomised crossover trial	N=7 paediatric surgeons; n=51 operations randomised to intervention (n=26) or control (n=25); 85.7% M	5-min intraoperative breaks every 30 mins (25-min work then 5-min break) vs control (no breaks)	*Measured before, during and/or after surgery:* 1) Salivary cortisol, amylase, testosterone, and DHEA; 2) BP-test of concentration and performance; 3) Fatigue items from NASA Task Load Index; 4) Perceived stress; 5) Pain (neck, arms, spine, knees, eyes); 6) Mean operation time corrected for complexity *Measured continuously:* 7) Heart rate and intraoperative ECG events (sudden increase in HR during stressful event)	Compared with control group, break group showed: 1) Salivary cortisol improvement (p<.05), lower testosterone for female participant (p<.001), N.S difference in amylase and DHEA. 2) Improvement in attention (p<.05) and concentration (p=.06) – error rate 3x lower than control, threshold significance due to outlier. 3) Less post-operative fatigue (p<.005), less intra-operative impairment by fatigue (p<.001) 4) Less intra-operative stress (p<.05) 5) Less musculoskeletal strain (all p<.001 except eyes, p=.09)

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
					6) No difference in mean operation time (breaks did not prolong operations, p>.05) 7) Fewer intraoperative events (p<.05), less increase in heart rate (p<.05)
Engelmann (2012) [34]* Germany Published report *Note: Follow-up to Engelmann 2011[33]. Includes patients as participants	RCT	N=7 paediatric surgeons and N=52 paediatric patients; surgeons 85.7% M	Patient outcomes and surgeon perceptions of 5-min intraoperative breaks every 30 mins (25-min work then 5-min break) vs control (no breaks)	*Patient outcomes measured during surgeries:* 1) Cardiovasular monitoring; 2) Urine volume; 3) Blood gas parameters; 4) Body temperature *Surgeon feedback measured 1 month after intervention:* 5) Team communication; 6) Team coordination; 7) Were there any welcome breaks vs any particularly unwelcome breaks?; 8) Overall scheme ratings; 9) Individual work style (fast, slow, exact, standardized, creative, alternating)	1-4) No difference between control and intervention groups in any patient outcomes. *Surgeon feedback:* 5) With breaks team communication changed from implicit (little verbal feedback) to explicit (outspoken) (p<.05) 6) More coordination required for break scheme but not significant (p>.05) 7) Unwelcome breaks scored N.S higher 8) Overall approval rating: 5.9/10 (+/- 3.2) 9) Slow operators more in favour of break scheme than fast operators (p<.05)
Hallbeck (2017) [35] USA Published report	Before-and-after study. 1 control day followed by 1 intervention day. Approx. 1 wk between control and intervention.	N=56 Consultant surgeons; 67.9% M	Control surgery day with no breaks vs one day of 1.5-2 min intraoperative microbreaks with guided exercises every 20-40 mins	*Measured pre- and post-surgery (control and intervention days):* 1) Surg-TLX and GOAL questionnaire; 2) Musculoskeletal pain (Adapted Nordic Musculoskeletal Questionnaire) *Measured after intervention:* 3) Physical performance; 4) Mental focus; 5) Distractions and workflow interruptions caused by breaks; 6) Desire to incorporate into routine	1) N.S difference in surgery duration, degree of difficulty, complexity, distractions, and mental and physical demands between intervention and control surgeries 2) Improvement in right and left shoulder pain (p<.001) with microbreaks compared with control 3) Improved by breaks: 62%; No change: 46% 4) Improved by breaks: 34%; No change: 53%; Reduced: 12% 5) Distractions: 2/10, Workflow interruptions: 2/10 6) 87% answered yes
Microbreak interventions - other					
Lemaire (2010) [36] Canada Published report	Before-and-after study. 2-day protocol	N=20 medical, surgical, and primary care staff physicians; n=17 day shifts, n=3 night shifts; 85% M	Standard/usual practice day vs one day of micro-food-breaks (delivery of 6 small daily meals)	*Measured at baseline (7:30am) and 2-hourly intervals until end of day:* 1) Simple reaction time and complex reaction time (Brain Checkers software); 2) Capillary blood glucose	1) Intervention improved speed and accuracy on simple reaction time test (p=0.01) and complex reaction time test (p<.001) 2) Blood glucose levels reduced on intervention day (p=0.03) and less variable

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
			Baseline day preceded intervention day, both days occurred within 2 wk period	samples (Precision Xtra Blood Glucose); 3) Volume of fluid consumed and urine voided; 4) Diet recall/food diaries; 5) Checklist of 17 hypoglycemic nutrition-related symptoms	3) Fluid intake (p=.04) and urine output (p=.008) improved by intervention 4) Intervention increased caloric intake (p=.008) 5) N.S reduction in hypoglycemic nutrition-related symptoms on intervention day (p=0.36). 70% ppts reported fewer symptoms or no change compared with baseline
Mengin (2021) [37] France Published report	Randomised control trial	N=47 ENT trainee doctors; 47.7% M	Effect of listening to a 5-min guided mindfulness meditation vs control track prior to a simulated consultation where doctors break bad news to patients	Measured post-simulation only 1) Performance (rated by blinded expert assessors on bad-news consultation scale); 2) Physician self-rated empathy (visual analogue scale); 3) Patient perception of physician empathy (Jefferson Scale of Patient Perceptions of Physician Empathy) Measured pre-intervention, post-intervention and post-simulation 4) Self-rated stress (visual analogue scale); 5) Doctor self-rated confidence (visual analogue scale)	1) Performance improved in mindfulness group compared with control group (p=.026). Fewer participants rated as "fail" by assessors in the mindfulness group than control (4.3% vs 30.4%, p =.04) 2) N.S difference in self-rated empathy 3) N.S difference in patients' perceived empathy across groups. Perceived empathy positively correlated with performance (r=0.541, p<.001). 4) N.S difference in perceived stress 5) N.S difference in doctor confidence
Survey and cohort studies					
Al Dandan (2020) [38] Saudi Arabia Published report	Cross-sectional survey	N=198 clinical radiology trainees, and consultants; 56.1% M	Break-taking prevalence as a predictor of digital eye strain	1) Symptoms of digital eye strain 2) Break frequency (% of participants) 3) Break duration (% of participants)	1) Infrequent break-taking (once or twice per day) was a predictor of digital eye strain compared with more frequent break-taking 2) 25.3% once/day, 30.8% twice/day, 32.3% every 2 hours, 11.6% at least hourly 3) 10.6% <5 mins, 45.0% 5-10 mins, 28.3% 11-15 mins, 16.1% >15 mins
Winston (2008) [39] England, UK Published report	Cross-sectional survey	N=328 hospital doctors of varying grades; M/F ratio not reported	Break prevalence and healthy eating behaviours	1) Study-specific checklist of potential barriers to healthy eating 2) Break prevalence	1) Lack of breaks rated the most common barrier to healthy eating (66%). Next most common barriers: Lack of food choices (56%) and canteen opening times (48%). 2) Prevalence of regular break taking: 46%

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Hassan (2020) [40] Egypt Published report	Cross-sectional survey	N=278 surgical and medical trainee doctors; 46.4% M	Association between break prevalence and level of work stress	Adapted version of the Hospital Consultants' Job Stress and Satisfaction Questionnaire (work characteristics rated for their contribution to work-related stress). Stress scores categorized as low, moderate and high.	High stress scores associated with lack of breaks during working hours (76.9% of low/moderate stress group not taking breaks vs 93.3% of high stress group not taking breaks, p=.001) Barriers to break taking: 50.7% of participants described rest areas as limited, 38.8% as sufficient for one person only, 1.8% as big enough, 8.7% reported no rest areas
Kirkcaldy (2002) [41] Germany Published report	Cross-sectional survey	N=309 doctors and consultants who own a medical practice; 63.4% M	Association between break duration and occupational stress, motor vehicle accident rates, and work-related accident rates	1) Study-specific questionnaire about occupational stress 2) Number of motor vehicle accidents 3) work-related accidents during previous 12 months 4) Break duration: Lunch break start and end time reported	1a) Occupational stress showed a significant negative association with lunch break duration (r=-0.19, p<.05) 1b) In predictor model of job stress break duration was significant (β=-0.16, p=.03) alongside 3 factors: weekly working hours, no. of dependent children and work satisfaction (R^2 adj = 0.12, p<.001) 2) Break duration not significant predictor of motor vehicle accident rates 3) In predictor model of work-related accidents, shorter lunch breaks were included (β=+.0.10, p<.10) alongside 1 factor: high levels of job commitment 4) Working longer hours significantly associated with shorter lunch breaks (p<.001)
Nitzsche (2017)[42] Germany Published report	Cross-sectional survey	N=152 private practice haematology and oncology physicians; 73% M	Association between breaks, emotional exhaustion and work-home conflict	1) Maslach Burnout Inventory (emotional exhaustion scale) 2) Work home conflict: Effect of work on private life (Survey Work-Home Interaction – NijmeGen) 3) Home-work conflict: Effect of private life on work 4) Two study specific questions about how often breaks are taken	1) Significant indirect effect of breaks on emotional exhaustion, mediated by work-home conflict (p<.05, β = -0.22). No direct effect. 2) Breaks directly related to work-home conflict. WHC reduced by breaks (β=-.33, p<.05). 3) No direct effect of breaks on home-work conflict. 4) 1/4 took regular breaks, 16% never took breaks.

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Kalboussi (2020) [43] Tunisia Published report	Cross-sectional survey	N=46 anaesthetists of varying grades; 11% M	Association between taking breaks at work (among other occupational factors) and burnout	1) Maslach Burnout Inventory 2) Breaks at work dichotomised into "Yes" or "No"	N.S association between burnout and break-taking (p=0.790)
Ohlander (2015) [44] Sweden & Germany Published report	Cross-sectional survey Data from the 2nd of 3 follow-up surveys in cohort study.	Swedish sample: N=85 physicians; 60% M. German sample: N=561 physicians; 48.5% M	Association between break duration and work stress in two different countries	1) Work stress (Effort-Reward Imbalance questionnaire) 2) Minutes of break per day	1a) Sweden: Negative association between work stress and break duration (β=-0.002, p=.03) 1b) Germany: N.S. association, break duration not included in regression model 2) German sample had shorter breaks per day than Swedish sample (28.2 +/- 18.1 min/day vs 40.4 +/- 20.9 min/day)
Berastegui (2020) [45] Belgium Published report	Observational prospective longitudinal study conducted over 10-month period	N=28 ED doctors; 60.7% M	Association between fatigue reduction strategies with a) reaction time, and b) burnout. Fatigue reduction strategies: Used to reduce subjective on-the-job fatigue e.g. rest, nap, have a snack, get fresh air, listen to music, etc.	*Measured at baseline only:* 1) Checklist of fatigue reduction strategies (FRS, checklist based on previous focus group data) 2) Maslach Burnout Inventory measured at baseline only *Measured during each shift (6:30-7:30pm for day shift, 9:30-11pm for night shift):* 3) Psychomotor Vigilance Task (PVT)	1) Higher FRS use significantly associated with faster reaction times on PVT (p=0.01) 2) FRS use not significantly associated with burnout
Hockey (2020) [46] England, UK Published report	Observational prospective longitudinal study	N=565 trainee doctors; 42% M	Association between breaks and positive and negative affect	*Tasks and affect measured during 2-hour windows. Repeated 5 times in different shifts.* Intensity of positive affect (competence, enjoyment, friendliness, happiness) and negative affect (worry, tiredness, impatience, hassle, frustration, criticism) when reporting a break	Compared to shifts with breaks, in shifts without breaks participants experienced significantly greater feelings of negative affect and significantly less feelings of positive affect on all measured domains.
Neprash (2018) [47] USA Conference presentation* *Report published did not include break data.	Retrospective cohort study (Secondary analysis of electronic records spanning	N=2,805 primary care doctors (n=703,612 appointments); M/F ratio not reported	Opioid, NSAID and physical therapy prescribing rates immediately before and after breaks of >15 mins (during appointments	1) Opioid, NSAID and physical therapy prescribing rates for outpatient appointments (per electronic health record systems) 2) Breaks: Gap of >15 mins in schedule	Doctors 4.9% more likely to inappropriately prescribe opioids before breaks than after (p=0.02) N.S. relationship with physical therapy orders and NSAID prescribing

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
	2013-2014 period)		where opioids were likely inappropriate)		
Vosshenrich (2021)[48] Switzerland Published report	Retrospective cohort study (secondary data analysis of trainee doctors' reports)	*N*=117,402 reports written by *n*=27 trainee doctors; M/F ratio not reported	Effect of lunch breaks on number of corrections made to trainee doctor's reports in proofreading process	Similarity (%) of preliminary reports to final corrected versions (Jaccard similarity coefficient)	Report similarity temporarily increased after breaks (lunchtime), suggesting recovery. However, recovery effect reduced as the week progressed and disappeared towards end of the week.
QUALITATIVE STUDIES					
Qualitative appraisals of interventions					
Lemaire (2011) [49]* Canada Published report *Note: qualitative follow-up to Lemaire 2010 quantitative intervention study[36]	Before-and-after study evaluation using semi-structured interviews	N=20 medical, surgical, and primary care physicians; 85% M	Standard/usual practice day vs one day of micro-food-breaks (delivery of 6 small daily meals) Baseline day preceded intervention day, both days occurred within a 2-week period	Semi-structured interviews before and after intervention (15-45 min duration) analysed inductively by 2 coders	Impact of inadequate nutrition: 1) Emotional symptoms (e.g. irritability); 2) Physical symptoms (e.g. inability to focus or concentrate); 3) Affects ability to work (efficiency, focus); 4) Affects interactions with others (colleagues and patients). Barriers to adequate nutrition: 1) Lack of time due to workload and schedule; 2) Lack of access to nutrition (distance of facilities, queues, opening hours); 3) Lack of food choices; 4) Work ethic (work/patients come first); 5) Professionalism (unprofessional to eat in patient areas). Impact of participating in the intervention: 1) Increased awareness of workplace nutrition and impact; 2) Intention to change future habits and eat more regularly.
Lockhart (2013) [50] Canada Conference abstract	One-group post-test only design using qualitative survey evaluation	N=5 rheumatology senior trainees; M/F ratio not reported	1-hour circuit-training-style exercise session for 12-week period instead of lecture as part of academic half-day	Qualitative survey administered in week 9 of 12	1) Program resulted in changes to diet, stress, sleep habits, mood, learning and time-off activities; 2) Participants perceived program as effective use of time and resources, preferable over teachings; 3) 4/5 participants desired focused instruction on beneficial exercises for patients; 4) 3/5 confidence in exercise prescribing

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
					increased; 5) 5/5 participants perceived work and training as barrier to exercise; 6) 3/5 had not previously participated in regular exercise. 2/5 participated twice wkly. Post-intervention 4/5 complete 1-3 sessions of exercise >30 mins.
Other qualitative studies					
Hall (2018) [51] England, UK Published report	Single occasion focus groups	N=25 General practitioners (locums, salaried, trainees, and partners); n=5 focus groups; 44% M	Breaks as potential strategy to improve general practitioner wellbeing	Inductive thematic analysis (2 coders)	Breaks: 1) Scheduled short breaks as feasible strategy to improve wellbeing. Lunch breaks not deemed realistic but short coffee breaks feasible; 2) Breaks as opportunity to leave the work space, interact with colleagues, and/or have respite from work; 3) Breaks valued where they are common practice and desired where they are not; 4) Increase in resources perceived as fundamental to enabling time for breaks
Morrow (2014) [52] UK (England, Scotland Wales, Northern Ireland) Published report	Focus groups and telephone interviews	N=82 medical, surgical and psychiatry trainee doctors; 44% M	Effect of UK Working Time Regulations (WTR) on trainees' experience of fatigue (including effect on breaks and rest periods)	n=11 focus groups (60-90 mins) and n=30 telephone interviews (30-45 mins) for participants who could not attend focus groups Analysed using a framework approach (2 coders)	WTR implementation in practice: 1) Fatigue still experienced despite regulations (e.g. due to work compression and intensity); 2) Rest facilities being reduced and less capacity to take breaks or rest; 3) Lost rest periods due to senior staff lack of awareness of them. Effects of fatigue: 1) Detriment to skills, judgement, efficiency, mood, ability to retain new information; 2) Effects compounded by hunger/discomfort from inability to take breaks
O'Shea (2020) [53] USA Published report	Focus groups	*N*=116 EM doctors (all grades); M/F ratio not reported	Beliefs about taking breaks for self-care while on shift	*n*=8 one-hour focus groups conducted separately with trainees and consultant doctors. Analysed for themes by 3 coders and validated by participants.	Six themes: 1) ED Doctors have innate physiological needs which affect cognitive function and emotional regulation; 2) Shared beliefs (culture) on break-taking relate to productivity and patient safety as a strength, and self-care as a weakness; 3) Breaks can create delays and negatively impact patient safety, though no participants had experienced this personally; 4) The ability to take breaks requires certain skills, safety-oriented communication strategies, and practice; 5)

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
					Changing the cultural norms would require approval from peers and other staff; 6) Breaks need to be flexible in form and duration and cater to individual needs and circumstances.
Walsh (2005) [54] Canada Published report	Semi-structured individual interviews	N=21 female family medicine trainee doctors; 0% M	Effect of access to breaks on ability to breastfeed when returning to work from maternity leave	Semi-structured individual interviews analysed for themes	1) Breastfeeding valued but often unable to continue at work. 2) Maintaining breastfeeding contingent on ability to take breaks to express breast milk. Additional requirements: privacy, good breast pump, refrigerated storage and sympathetic seniors.
MIXED METHOD STUDIES					
Wilkesmann (2016)[55] Germany Published report	Sequential mixed method design	N=43 qualitative semi-structured interviews with hospital physicians; N=2,598 quantitative surveys from surgeons and anaesthetists (trainee doctors excluded); M/F ratio not reported	Impact of breaks on opportunities for physicians to 'share ignorance' (detect unknown things and share them, ability to learn from failures) or 'hide ignorance' (intentionally prevent knowledge sharing) Ignorance: a known or unknown lack of knowledge	1) Qualitative semi-structured interviews analysed using content analysis firstly deductively then inductively to form hypotheses for subsequent testing in the quantitative survey 2) Quantitative survey item: Effect of breaks ("I usually take opportunities to discuss work related things in my work break with colleagues") on a) hiding ignorance and b) sharing ignorance	1) <u>Qualitative findings:</u> Breaks could serve as informal, face-to-face opportunity to share ignorance and learn from it 2) <u>Quantitative findings:</u> a) Breaks had N.S. effect on hiding ignorance (p=0.64) b) Breaks had a significant effect on sharing ignorance (p<.001)

Legend and Abbreviations: 'Trainees' – includes any/all grades unless specifically stated. Consultants – fully trained in specialty, includes 'attending physicians/ surgeons'. EM – Emergency Medicine specialty. ED – Emergency department. OBGYN – Obstetrics and Gynaecology. ENT- Ear, Nose and Throat. NSAIDS – non-steroidal anti-inflammatory medication. WTR – working time regulations. UK- United Kingdom. RCT- Randomised control trial

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	P1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	P2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	P3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	P3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	P4-5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Supp p2-6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supp p2-6
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	P5-6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	P5-6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	n/a
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	n/a
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	P6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	n/a
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	n/a
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	n/a
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	n/a
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	n/a
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	n/a
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	n/a
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	n/a
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	n/a

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Fig 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	n/a
Study characteristics	17	Cite each included study and present its characteristics.	Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Table 2-6
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	n/a
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	n/a
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	n/a
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	n/a
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	n/a
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	n/a
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	n/a
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pp18-19
	23b	Discuss any limitations of the evidence included in the review.	P18
	23c	Discuss any limitations of the review processes used.	P18
	23d	Discuss implications of the results for practice, policy, and future research.	P19
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	P2
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	P2
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	n/a
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	P20
Competing interests	26	Declare any competing interests of review authors.	P20
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	n/a

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

PRISMA 2020 Checklist

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

BMJ Open

Impact of intra-work rest breaks on doctors' performance and wellbeing: systematic review

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-062469.R1
Article Type:	Original research
Date Submitted by the Author:	03-Oct-2022
Complete List of Authors:	O'Neill, Aimee; University of Southampton Faculty of Medicine Baldwin, David; University of Southampton Faculty of Medicine Cortese, Samuele; University of Southampton, Sinclair, Julia; University of Southampton, Academic Centre
Primary Subject Heading:	Occupational and environmental medicine
Secondary Subject Heading:	Mental health
Keywords:	MENTAL HEALTH, Human resource management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Word Count 4338

Title Page

Impact of intra-work rest breaks on doctors' performance and wellbeing: systematic review

Aimee O'Neill [1], David S. Baldwin [1,2], Samuele Cortese [1,3,4,], Julia M.A. Sinclair [1*]

[1] Clinical and Experimental Sciences, Faculty of Medicine, University of Southampton, UK
[2] University Department of Psychiatry and Mental Health, University of Cape Town, Cape Town, South Africa
[3] Centre for Innovation in Mental Health, School of Psychology, Faculty of Environmental and Life Sciences, University of Southampton, Southampton, UK.
[4] Solent NHS Trust, Southampton, UK.

*Correspondence: Professor Julia Sinclair
University Department of Psychiatry, College Keep, Terminus Terrace, Southampton, SO14 3DT, Tel: 023 82 310764 Fax: 023 82 310766 Email: julia.sinclair@soton.ac.uk

Keywords: Mental Health, Human resource management, wellbeing; fatigue, burnout

Abstract

Objectives: To summarise evidence on intra-work breaks and their associated effect on doctors' wellbeing and/or performance at work.

Methods: Embase, PubMed, Web of Science (Core Collection), and PsychINFO were systematically searched on 6.6.2021, with no restrictions on date/language, study design or date of publication. Methodological quality was appraised using Cochrane's Risk of Bias (ROB-2), Cochrane's Risk of Bias in Non-randomised Studies (ROBINS-I), and the Johanna Briggs Institute checklists for cross-sectional, cohort and qualitative studies. As a systematic review of the literature no ethical approval was required. Quantitative synthesis was not undertaken due to substantial heterogeneity of design and outcomes. Results are presented narratively.

Results: Database searches returned 10,557 results and searches of other sources returned two additional records. Thirty-two papers were included in the systematic review, comprised of 29 unique studies, participants and topics, and three follow-up studies. A variety of wellbeing and performance outcome measures were used. Overall, findings indicate that intra-work breaks improved some measures of wellbeing and/or work performance. However, methodological quality was judged to be low with a high risk of bias in most included studies.

Discussion: Using existing evidence, it is not possible to conclude with confidence whether intra-work breaks improve wellbeing and/or work performance in doctors. There is much inconsistency regarding how breaks are defined, measured, and the outcomes used to assess effectiveness. Future research should seek to: a) define and standardise the measurement of breaks; b) use valid, reliable outcome measures to evaluate their impact on wellbeing and performance; and c) minimise the risk of bias in studies where possible.

PROSPERO registration number: CRD42020156924 (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=156924)

Strengths and limitations of this study

- No limits were placed on design, country or language to ensure a comprehensive review of the subject area
- Review complies with PRISMA 2020 statement and was prospectively registered on PROSPERO before commencement
- As meta-analysis was not possible, data are qualitatively synthesised

Introduction

The overwhelming strain placed on health professionals across the globe in responding to the Covid-19 pandemic is well recognised.[1] However, this is on the backdrop of increasing concern about the risk of burnout of doctors in training and the impact this may have on patient care.[2-8] A report in 2019 by the British Medical Association (BMA) [2] suggested approximately 80% of UK doctors and doctors in training are at high or very high risk of burnout. Though figures vary depending on choice of outcome measure and health system, it is generally acknowledged that rates of burnout and psychiatric morbidity among doctors are worryingly high.[3] Impairment to doctors' wellbeing negatively affects patient care, [4] patient outcomes,[5] and increases the chance of medical errors,[6, 7] notwithstanding an association with reduction in clinical hours and retention of doctors.[8, 9] As such, the wellbeing of doctors is a concern for many organisations, and recommendations have been formulated to address burnout and improve doctors' wellbeing. [10, 11] These include the necessity to reduce doctor fatigue [12, 13] and many highlight the importance of breaks for reducing fatigue, improving patient safety, and promoting wellbeing at work. [13-15] In response to these recommendations and campaign efforts (e.g., the *BMJ*'s "Give Us a Break" campaign [16]) in the UK, investments have been made to improve rest facilities. [17]

What constitutes a "break" within the work context is a wide and variably defined construct, including: holidays and annual leave, career breaks, as well as the temporary reprieve taken within a given shift at work (intra-work breaks). A systematic review of the impact of intra-work breaks in industrial settings showed that intra-work breaks in that context maintained performance and helped mitigate fatigue and accident risk. [18] However, it remains unclear whether intra-work breaks improve doctors' wellbeing and performance as, to our knowledge, no review has been conducted on break-taking literature in this population. This systematic review seeks to specifically understand the impact of *intra-work* breaks on doctors' wellbeing and/or their performance at work.

Method

This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 statement. The protocol was pre-registered with the International Prospective Register of Systematic Reviews (PROSPERO CRD42020156924). [19]. As a systematic review of the literature no ethical approval was required.

Patient and Public Involvement: This systematic review is part of a PhD thesis undertaken in the Centre for Workforce Wellbeing at the University of Southampton. As part of that process there was significant engagement with junior doctors, consultants and patients about the priorities for doctors' wellbeing and outcome measurement.

Eligibility criteria

The review included any empirical studies investigating the impact of intra-work breaks on doctors' wellbeing and/or performance.

In the absence of an established definition of an intra-work break we developed an operational one as follows: A cessation of work tasks for a period of up to an hour during a given shift, allowing the individual to temporarily remove themselves from the workspace, physically and/or mentally. An hour period was chosen, as this is typically the maximum duration of lunch breaks in other industries and, for sleep-related break interventions, this would differentiate shorter naps from the equivalent of overnight sleep.

Break 'interventions' could include opportunities to rest, mandating breaks, increased frequency of breaks, increased break duration, varied timing of breaks, or break activities (e.g. yoga, exercise).

Where the study design necessitated a comparator, this could include usual practice, missed work breaks, less frequent breaks, shorter break durations, or other break activities.

We included any empirical study design or investigation, undertaken primarily in qualified medical doctors (doctors comprising at least 50% of the sample). Some papers might refer to junior doctors as 'trainees'. Despite being fully qualified, this is a common term for doctors who are not yet consultants.

No restriction was placed on study design (quantitative or qualitative), language, location, or date of publication.

Studies were excluded if:

1) the break under investigation occurred outside of work hours;
2) the break under investigation included a work-based activity (e.g. reflective practice or administration);
3) qualified doctors did not constitute the majority of the sample;
4) the design was not empirical (e.g. opinion pieces, reviews, theoretical modelling);
5) the break duration was longer than an hour.

The primary outcome of the systematic review was the measured effect(s) of break taking on doctors' wellbeing or work performance.

Search strategy

We searched, until 6th June 2021, Embase, PubMed, Web of Science (Core Collection), and PsycINFO databases, using Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH). Bramer et al. [20] estimate that this combination should ensure at least 83% coverage of available literature, though this figure is likely to be higher due to PsycINFO being a comparatively more relevant database in this subject area than those included in their calculation. Reference lists of key research papers or reviews were also searched for additional papers not retrieved by the search strategy.

The search comprised three blocks of terms and their synonyms relating to: 1) medical doctors, 2) intra-work breaks, and 3) an outcome measure of wellbeing (e.g. burnout, stress, anxiety, fatigue, sleep) and/or work performance (e.g. errors, job performance indicators, quality of care, staff absence). Syntactic variations were adapted for each database. See Supplementary Material for the search strategy used for each database.

"Wellbeing" and "work performance" are broad constructs that lack a single definition. As we aimed to be as broad as possible in this search, capturing the breadth of research in the field, we wished to encompass as many working definitions of these constructs as possible through a comprehensive list of search terms. Wellbeing outcomes referred to any measures of, or related to, mental health, physical health and quality of life. Work performance included any measures of, or related to, clinicians' ability to carry out their duties, such as errors, adverse events, appraisals, patient feedback, quality of care, revalidation, ability to meet targets, and so forth. Outcomes relating to wellbeing and work performance also often overlap (e.g. sickness absence, perceived stress) therefore it was not our intention to divide the two constructs but rather to be inclusive of any papers investigating either, or both, outcomes. We referred to research papers in the fields of

occupational wellbeing and job performance to gather the extensive list of terms and a subject librarian was consulted throughout to ensure the comprehensiveness of the search.

Study selection

Search results were imported into EndNote X9® software and duplicates were automatically and manually removed. Each study title and/ or abstract was assessed by two independent assessors against the inclusion criteria, with an agreement rate of 98.2%. If disagreements occurred between assessors, consensus was achieved through arbitration by a third senior author. Where abstracts indicated potential relevance to the review, corresponding full text papers were screened for inclusion. If full text articles were not available in accessible databases, through inter-library loan, and/or relevant information was not fully explained in the text, authors were contacted for relevant data via e-mail (at least twice). If corresponding peer reviewed reports were not available, even after request to the corresponding author, conference abstracts were assessed and those with sufficient information for data extraction were included.

Data extraction and analysis

We extracted: first author; year of publication; participant demographics (training level/seniority, speciality/department, gender); location; sample size; study design; definition/type of break; interventions/activities under investigation (and any comparators); evaluated outcome measurements; and associated results. If reported, data extraction also included break prevalence, timing and duration of breaks, and hindrances or facilitators to break taking. Data extraction for each study was completed by the primary author using a standardised table, and all data extraction was verified by a second, senior author throughout the extraction process.

Data were tabulated for cross-comparison and descriptive analysis. The outcomes of included studies were described according to whether they improve, reduce or have no effect on wellbeing and/or job performance outcome measures. Due to the substantial variability in study methods, populations and outcome measures used, no meta-analysis was conducted on the data.

Quality appraisals

An assessment of the risk of bias was made by two reviewers independently using the Cochrane risk of bias tool for randomised control trials (ROB-2)[21]. The Cochrane ROBINS-I tool [22] was used to assess non-randomised studies of interventions. Both Cochrane tools allow for an overall risk of bias

assessment (ROB-2: low risk of bias, some concerns, high risk of bias; ROBINS-I: low, moderate, serious, or critical risk of bias, or no information).

For other experimental designs, risk of bias assessment was completed using the relevant Joanna Briggs Institute (JBI) checklists [23] for cross-sectional, cohort, and qualitative studies. Each question is answered with "yes", "no", "unclear" or "not applicable". The JBI checklists do not provide an overall risk of bias, however, to allow for intra- and cross-study comparison, we have indicated the frequency (%) of possible "yes" answers within each study and across studies. As JBI checklists contain less detail than Cochrane tools, our rationale for JBI ratings are given in Supplementary Tables 1-3.

Follow-up studies were assessed separately if the design and/or participants were dissimilar to the original paper.

Results

Insert Figure 1 about here

Following removal of duplicates, the titles and abstracts of 10,557 records were assessed for inclusion in the review (see figure 1). Supplementary searches yielded two further records. In total, 32 records met criteria for inclusion. Three records report follow-up data to original papers and as such 29 records contain unique participants and topics.

See Supplementary Table 4 for the summary of results.

Records meeting the inclusion criteria ranged in publication date from the year 2002 to 2021. There was substantial heterogeneity in study design, including randomised control/crossover trials (n=7), non-randomised studies of interventions (n=7), cross-sectional surveys (n=7), cohort (n=4), qualitative (n=6) and mixed-method studies (n=1).

Intervention studies generally comprised relatively small sample sizes, ranging from 7 to 56 participants (median: 27). Of these, the six randomised control trials had sample sizes ranging from 7 to 49 participants (median: 37). Survey and cohort studies were moderately sized, ranging from 27 to 2,805 participants (median: 294). Qualitative study sample sizes were varied, ranging from 5 to 116 participants (median: 25).

The break-related topics of investigation were also highly varied. Intervention studies investigated the effect of 'microbreaks' (particularly in the specialty of surgery), naps, yoga or exercise sessions,

and standard 30-minute breaks. Surveys and cohort studies investigated a wide range of break-related topics, including: the impact of breaks on digital eye strain, reaction time, burnout, stress, affect, vehicle and work-related accidents, inappropriate prescribing, emotional exhaustion, work-home conflict, report errors and healthy eating behaviours. Qualitative methods were used to appraise break interventions as well as to investigate diverse topics such as the importance of breaks to new mothers' ability to continue breastfeeding following maternity leave, the potential of breaks to improve clinician wellbeing and fatigue, the culture surrounding breaks, and clinician opinions on them. Mixed-method data investigated the role of breaks on 'sharing ignorance' (detecting and sharing unknown knowledge and learning from failures) and 'hiding ignorance' (deliberately preventing knowledge sharing).

Wellbeing and performance outcome measures were also dissimilar across studies. Given the substantial variability in types of intervention implemented, and measures of outcome (see Supplementary Table 4 for full details), inherent heterogeneity in the data meant that any quantitative synthesis could generate spurious findings, and so was not undertaken.

Impact of breaks on wellbeing and performance outcome measures

As study design and break types under investigation varied markedly, they are described here by topic and data type to aid clarity, including: quantitative studies of standard 30-minute breaks, [24, 25] sleep-related interventions (naps), [26, 27] yoga and mindfulness interventions, [28-31] microbreaks in surgery, [32-35] other microbreak interventions, [36, 37] surveys, [38-44] and cohort studies. [45-48] Qualitative data are grouped into qualitative evaluations of interventions [49, 50] and other qualitative studies, [51-54] and a single German sequential mixed-method study investigating the impact of breaks on opportunities for physicians to share (or hide) ignorance. [55] (see Supplementary Table 4).

Quantitative study findings: Break interventions

Results for standard 30-minute breaks were mixed. A German double-blind cross-over trial [24] saw no changes to attention, sleepiness or anxiety measured during the shift, whilst an Australian before/ after study [25] found breaks improved clinicians' tiredness, fatigue when measured at the end of each shift, and departmental performance (time to see patients, triage and target admission times).

Two sleep-related interventions [26, 27] conducted in the US showed overall improvement to wellbeing and performance during both day and night shifts. Twenty-minute midday naps in day shifts were associated with improvements in cognitive functioning and attentional failures in first year interns, [26] while 40-minute naps during night shifts showed improvement to reaction times, mood, sleepiness, and driving performance in Emergency Department (ED) staff. [27] However, no significant changes were seen in memory and simulations of intravenous tasks. .

Studies investigating yoga and mindfulness offered the one hour sessions within work hours. [28-31] These studies (two before/ after [28, 29] and two randomised controlled trials (RCTs) [30, 31]) found overall positive improvements to wellbeing and performance measures such as burnout, anxiety, depression, stress, blood pressure, sleep, professional fulfilment, interpersonal disengagement, resilience, and mindfulness. However, no changes were seen in heart rate, [29] subjective sleep scores, [28] sleep disturbances and affect. [31] The US study in faculty physicians [31] found that positive findings of reduced burnout, stress, anxiety, and depression, and increased professional fulfilment, were not sustained at a two-month follow-up; whilst another in US obstetric trainees [29] found an overall increase in participants' weight following the implementation of a yoga programme.

To reduce the common musculoskeletal difficulties associated with prolonged surgery, the effect of microbreaks (breaks of approximately 5 minutes or less) were tested in surgeons in Canada, USA and Germany, using parallel RCT, [34] randomised crossover trials [32, 33] and before/ after study design. [35]

Results were predominantly positive. Five-minute microbreaks every 30 minutes saw improvements to musculoskeletal strain, cortisol, attention, concentration, doctors' responses to stressful intra-operative events, intra- and post- operative impairment by fatigue, and stress – without prolonging the duration of a given surgery nor affecting patient outcomes. [33, 34] However, doctors' approval of this type of scheme depended on their preferred way of working. [34] Studies also tested microbreaks of a shorter duration (20-second pauses every 20 minutes and 1.5-2 minute breaks every 20-40 minutes), and despite the shorter break time, showed predominantly positive effects. [32, 35] Twenty-second microbreaks showed improvements to physical discomfort, muscular fatigue, and accuracy, [32] while breaks of 1.5-2 minutes showed improvement to musculoskeletal pain, physical performance and, for some surgeons, mental performance, with no or minimal effect on surgery duration, difficulty, complexity, distractions, work flow or mental/physical demands. [35] Additionally, the majority of surgeons expressed a desire to incorporate this type of shorter micropause into their regular routine. [35]

Other microbreak interventions included a Canadian study delivering micro-food breaks (six small meals) throughout the work day; [36] and (in France) five-minute mindfulness meditations prior to breaking bad news to patients. [37] Micro-food breaks were found to have positive effects on speed and accuracy, blood glucose levels, fluid intake, urine output, and caloric intake though no significant reduction in hypoglycaemic nutrition-related symptoms. [36] Five minute mindfulness meditations had a positive effect on performance during a simulated bad news consultation, however, it had no significant effect on doctors' stress, confidence, or self- or patient- perceived empathy. [37]

Quantitative study findings: Survey and cohort studies

Cross-sectional surveys investigated various topic areas and used a variety of measures to investigate the impact of break taking. A survey of radiologists in Saudi Arabia found that infrequent break taking was predictive of digital eye strain, [38], whilst in the UK [39] doctors reported lack of breaks as the most common barrier to healthy eating. Two studies (In Egypt and Germany) [40, 41] found that fewer breaks correlated with, or were predictors of, higher stress levels. Whereas a survey of physicians in private practice [42] found that break taking negatively correlated with work-home conflict and indirectly correlated with emotional exhaustion. However, a small survey of 46 Tunisian anaesthetists of varying grades [43] found no association between break-taking behaviours and levels of burnout. The survey of German doctors [41] also found that while shorter break duration was a predictor of work-related accidents, it was not a predictor of motor vehicle accident rates.

Additionally, one cross-national survey [44] showed break duration negatively correlated with doctors' work stress in Sweden but not in Germany.

Cohort studies were prospective and retrospective in design and reported on a variety of measures. One prospective cohort study in Belgium Emergency Department physicians [45] found that greater use of fatigue reduction strategies (break activities) were associated with faster reaction times but not with levels of burnout. A UK study in trainees [46] found that the lack of breaks during shifts was associated with greater negative affect (worry, tiredness, impatience, frustration etc.) and less positive affect (competence, enjoyment, happiness etc.). A retrospective cohort study using secondary analysis of electronic records in the US [47] found that doctors were more likely to inappropriately prescribe opioids before than after a break, whilst another in Switzerland [48] showed that report errors (as a surrogate marker of fatigue) reduced after breaks, though this post-break effect waned as the week progressed.

Qualitative findings: Qualitative appraisals of break interventions

Two studies qualitatively appraised interventions. One [49] used individual interviews to follow-up the aforementioned Canadian micro-food break study, [36] and found that lack of time, access to break areas, and lack of food choices were barriers to adequate nutrition, which in turn impacted doctors' emotional and physical symptoms, their ability to work, and their interactions with colleagues and patients. However, the intervention created greater awareness of nutrition in the workplace and prompted some doctors to change their habits and eat more regularly.

Another small (n=5) qualitative study of an intervention [50] used a survey to appraise a weekly one hour intra-work exercise session in Canadian rheumatology fellows. Participants reported that work was a barrier to their desired exercise regime, and felt the program was an effective use of time and resources. The majority found that the programme increased their confidence and following the programme the majority were continuing to exercise more regularly.

Qualitative findings: Other

Other qualitative studies used focus groups and individual interviews with doctors, and thematically analysed discussions about various break-related topics with a wellbeing or performance component. [51-54]

One (UK) focus group study investigated themes regarding breaks as a potential strategy to improve general practitioner (GP) wellbeing. [51] GPs described breaks as a valuable, desirable opportunity to remove oneself from the workplace that is a feasible wellbeing improvement strategy, though shorter coffee breaks were deemed more feasible than lunch breaks.

Another focus group study [53] investigated US Emergency Department doctors' thoughts about the function of breaks. Themes included doctors' need for breaks for cognitive and emotional functioning, however, when breaks were taken for the benefit of patients or productivity this was more acceptable than if they were taken for self-care alone. Doctors expressed the view that breaks had the potential to hinder work (though this was stated to have never been personally experienced) and that taking them required flexibility and attuned organisational skills. Additionally, any culture change around doctors' break taking was thought to require 'buy-in' from colleagues and other staff.

A UK focus group study [52] investigated the impact of Working Time Regulations on the experience of fatigue. Themes included fatigue being a threat to doctors' performance (e.g. efficiency and skills)

and that this worsened with hunger or discomfort caused by missed breaks. Participants expressed that fatigue was still experienced despite the implementation of regulations, that rest areas were increasingly being reduced, and that senior staff seemed to lack awareness of trainee entitlements to rest.

Finally, an interview study [54] with doctors who were also new mothers found that whilst they valued the ability to breastfeed, this was dependent on their ability to take breaks to express milk.

Mixed-method findings

The only included mixed-method study [55] investigated the phenomenon of sharing ignorance and hiding ignorance. The qualitative component of the study (individual interviews) identified breaks as an opportunity to share and hide ignorance, while the quantitative survey showed that breaks significantly facilitated sharing, but not hiding, ignorance.

Quality assessment

The methodological quality of included studies was rather low (see Tables 1-5). The risk of bias in randomised studies ranged from 'some concerns' to 'high' (see Table 1), whilst in quasi-experimental studies ranged from 'moderate' to 'critical' (see Table 2), with most studies being at 'critical' risk of bias. This was predominantly due to inherent confounding, a lack of comparator or control groups, the use of subjective criteria, and a lack of blinding to intervention status. No randomised or quasi-experimental studies had pre-published their protocols and/or analysis intentions.

Table 1. Risk of bias in Randomised crossover/controlled studies (Cochrane ROB-2)

Study	Domain							Overall risk of bias
	Bias due to randomization process	Bias from period and carryover effects	Bias due to deviations from intended interventions (effect of assignment to intervention)	Bias due to deviations from intended interventions (effect of adhering to intervention)	Bias due to missing outcome data	Bias in measurement of outcomes	Bias in selection of reported result	
Coburn (2006)[24]	Low	Low	Low	Low	Low	Low	Some concerns	Some concerns
Dorion (2013)[32]	Some concerns	Low	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns
Engelmann (2011)[33]	Low	Some concerns	Low	Some concerns	Low	Low	Some concerns	Some concerns
Engelmann (2012)[34]*	Low	-	Low	Some concerns	Low	Some concerns	Some concerns	Some concerns
Ireland (2017)[30]	Some concerns	-	Low	Some concerns	Low	Low	Some concerns	Some concerns
Mengin (2021)[37]	Some concerns	-	Low	Low	Low	Low	Some concerns	Some concerns
Smith-Coggins (2006)[27]	Low	-	Low	Low	Low	Low	Some concerns	Some concerns

*Note: While Engelmann (2011) and Engelmann (2012) are write-ups of one research study and share some participants (doctor participants), Engelmann (2012) introduces a new group of participants (patients), data and methodology (parallel design) requiring a separate assessment of bias.

Table 2. Risk of Bias in Quasi-experimental studies (ROBINS)

Study	Domain	Overall risk of

	Bias due to confounding	Bias in selection of participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported results	bias
Amin (2012)[26]	Critical	Low	Low	Low	Low	Low	Moderate	Critical
Babbar (2019, 2021)[28, 29]	Critical	Low	Low	Moderate	Low	Serious	Moderate	Critical
Hallbeck (2017)[35]	Moderate	Low	Low	Low	Moderate	Low	Moderate	Moderate
Lemaire (2010)[36]	Moderate	Low	Low	Low	Low	Low	Moderate	Moderate
Mitra (2008)[25]	Serious	Critical	Low	Critical	Serious	Serious	Moderate	Critical
Scheid (2020)[31]	Critical	Low	Low	Serious	Low	Serious	Moderate	Critical

Table 3. Risk of bias in Observational cohort study (JBI)												
Study	**Q1***	**Q2***	**Q3**	**Q4**	**Q5**	**Q6***	**Q7**	**Q8**	**Q9***	**Q10***	**Q11**	**% applicable 'yes' answers**

Bérastégui (2020)[45]	N/A	N/A	No	No	Yes	N/A	Yes	Yes	Unclear	Unclear	Yes	50.0
Hockey (2020)[46]	N/A	N/A	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	100.0
Neprash (2018)[47]	N/A	N/A	Yes	Yes	Yes	N/A	Yes	Yes	N/A	N/A	Yes	100.0
Vosshenrich (2021)[48]	N/A	N/A	No	Yes	No	N/A	Yes	Yes	N/A	N/A	Yes	66.7
% studies scoring 'yes' per question	-	-	50.0	75.0	75.0	-	100.0	100.0	50.0	50.0	100.0	

Q1: Were the two groups similar and recruited from the same population?
Q2: Were the exposures measured similarly to assign people to both exposed and unexposed groups?
Q3: Was the exposure measured in a valid and reliable way?
Q4: Were confounding factors identified?
Q5: Were strategies to deal with confounding factors stated?
Q6: Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?
Q7: Were the outcomes measured in a valid and reliable way?
Q8: Was the follow up time reported and sufficient to be long enough for outcomes to occur?
Q9: Was follow up complete, and if not, were the reasons for loss to follow up described and explored?
Q10: Were strategies to address incomplete follow up utilized?
Q11: Was appropriate statistical analysis used?

*Note: Q1-Q2 not applicable as no included cohort studies included control/comparison groups. Q6 is not applicable as participants were not free of outcome prior to study commencement (e.g. prescribing rates, intensity of positive/negative affect, etc.). Q9-Q10 not applicable to retrospective cohort studies.

Table 4. Risk of bias in Cross-sectional studies (JBI)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	% 'yes' answers
Al Dandan (2020)[38]	Yes	Yes	No	No	Yes	No	Yes	Yes	62.5
Hassan (2020)[40]	Yes	Yes	No	No	No	No	Yes	Yes	50.0
Kalboussi (2020)[43]	Yes	Yes	Unclear	Unclear	Yes	No	Yes	Unclear	50.0

Kirkcaldy (2002)[41]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.0
Nitszche (2017)[42]	Yes	Yes	No	No	Yes	No	Yes	Yes	62.5
Ohlander (2015)[44]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.0
Winston (2008)[39]	Yes	Yes	Unclear	No	Yes	No	No	Yes	50.0
% studies scoring "yes" per question	100.0	100.0	28.6	28.6	85.7	28.6	85.7	85.7	

Q1: Were the criteria for inclusion in the sample clearly defined?
Q2: Were the study subjects and the setting described in detail?
Q3: Was the exposure measured in a valid and reliable way?
Q4: Were objective, standard criteria used for measurement of the condition?
Q5: Were confounding factors identified?
Q6: Were strategies to deal with confounding factors stated?
Q7: Were the outcomes measured in a valid and reliable way?
Q8: Was appropriate statistical analysis used?

Table 5. Risk of bias in Qualitative studies (JBI)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	% 'yes' answers
Hall (2018)[51]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	90.0
Lemaire (2011)[49]	Unclear	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	80.0
Lockhart (2013)[50]	Unclear	Yes	Yes	Yes	Yes	No	Unclear	Unclear	Unclear	Yes	50.0

Morrow (2014)[52]	Unclear	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	70.0
O'Shea (2020)[53]	Unclear	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	80.0
Walsh (2005)[54]	Unclear	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	70.0
Wilkesmann (2016)[55]	Unclear	Yes	Yes	Yes	Yes	No	No	Unclear	Unclear	Yes	50.0
% studies scoring "yes" per question	14.3	100.0	100.0	100.0	100.0	28.6	14.3	71.4	71.4	100.0	

Q1: Is there congruity between the stated philosophical perspective and the research methodology?
Q2: Is there congruity between the research methodology and the research question or objectives?
Q3: Is there congruity between the research methodology and the methods used to collect data?
Q4: Is there congruity between the research methodology and the representation and analysis of data?
Q5: Is there congruity between the research methodology and the interpretation of results?
Q6: Is there a statement locating the researcher culturally or theoretically?
Q7: Is the influence of the researcher on the research, and vice versa, addressed?
Q8: Are participants and their voices, adequately represented?
Q9: Is the research ethical according to current criteria, for recent studies, and is there evidence of ethical approval by an appropriate body?
Q10: Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?

Using the relevant JBI checklist, observational studies (see Table 3) met 62% to 100% of applicable criteria; however, many of the questions posed by the checklists were not applicable due to the design of these studies (two were retrospective) and a lack of control or comparison groups.

Cross-sectional designs (see Table 4) met 50% to 100% of the relevant JBI criteria. In the absence of a standardised, objective measure of break taking, it is not surprising that only two of seven (28.6%) studies [41, 44] used standard, valid, objective criteria for measurement of break-taking. In these studies, break duration was measured in minutes where other studies dichotomously asked whether participants took breaks at work ("yes" or "no") or used a non-validated Likert-type scale dividing break frequency or duration into categories. Additionally, these were the only cross-sectional studies that reported appropriate methods to deal with confounding, despite most studies identifying potential confounders.

Qualitative studies (see Table 5) met between 50% and 90% of the JBI checklist criteria. Only two of the seven (28.6%) qualitative studies [49, 51] reported the cultural or theoretical position of the researcher, and one study [53] acknowledged the researcher's potential influence on the data.

Discussion

The breadth of break-related topics show that efforts are being made to investigate break effectiveness in doctors. Overall, the existing literature suggests a positive effect of break taking on a range of wellbeing and performance outcomes. However, comparison of data is hindered by a lack of consensus about which break-related topics and research questions should be prioritised, how these should be researched and measured, and what defines a break, alongside heterogeneity in the type of study design.

Only two included studies investigated the effectiveness of standard 30-minute breaks [24, 25], which requires particular attention as it is likely the most common type of break taken by doctors at work. Similarly, only two studies investigated the effect of naps, another common topic of discussion for performance and wellbeing, particularly for nights and long shifts.

It is unclear whether the content or duration of breaks is more important than the ability to take one. There were mixed findings for standard 30-minute uninterrupted breaks, though this is likely due to a lack of studies on the topic. Naps, microbreaks, and yoga and mindfulness interventions showed improvement to wellbeing and/or performance outcomes. However, outcome measures were dissimilar across studies, preventing valid comparison of break interventions and durations.

Overall, the quality of studies on break effectiveness was rated as sub-optimal. While sample sizes for survey and cohort studies were moderate, small samples were used in intervention studies and randomised control trials. Additionally, existing experimental (and non-experimental) studies carry a moderate to severe risk of bias due to inherent confounding, a lack of blinding, or control groups. This is problematic as experimental designs would provide the best approximation of break effectiveness and causality. While the feasibility of blinded experiments in break-taking research is low and unlikely, there is scope to reduce confounding and introduce more randomised control trials in this area.

Qualitative research provides some nuanced understanding of break phenomena, however existing qualitative literature does not tend to locate researchers culturally, theoretically and philosophically, nor does it acknowledge the potential influence of the researcher on findings.

As a construct, intra-work breaks lack an agreed definition and a standardised means of measurement. There appears to be no consensus on what delineates a break (temporally, contextually or behaviourally), or how to measure it reliably and validly. Indeed the use of validated instruments for measures of wellbeing or performance was low overall. This lack of agreement further prevents comparisons of data and conclusions about the effectiveness of breaks.

As (to our knowledge) this is the first systematic review of break taking in doctors, we did not place any limits on study design. Whilst this provides a comprehensive review of existing empirical evidence, this review also highlights the substantial variability in types of intervention implemented and measures of outcome used, resulting in a marked heterogeneity of data which makes further quantitative synthesis potentially misleading.

Given the heterogeneity in design, quality, research questions, and outcomes of existing studies, it is not possible to conclude with certainty whether intra-work breaks improve wellbeing and performance in doctors, though the existing evidence suggests a positive trend. This positive effect aligns with existing research in industrial contexts, [18] despite contextual differences between industry and healthcare settings.

To properly understand the effectiveness of breaks for doctors and justify financial and organisational investment in break facilitation, agreement among policy makers, regulators and research bodies regarding the research priorities would allow the evidence base to be developed quickly and effectively. From the results of this systematic review, such priorities could include: agreed international standardised definitions of intra-work breaks, development of outcome measures of wellbeing for doctors [56]; and consensus on the most robust methodologies to test

the effectiveness of intra-work break interventions in real-world situations. There is clearly a need for valid and reliable outcome measures that do not conflate wellbeing with the absence of distress [57], across a range of potential performance outcome measurements, as well as ways of measuring impact on patient care. [58]

The Covid-19 pandemic has highlighted the importance of ensuring workforce well-being, but the evidence of what works best for whom in terms of intra-work breaks remains uncertain.

Contributors: AON: designed the study, collected, analysed and interpreted the data and wrote the first draft of the article. She led on the response to reviewers. JS overseeing study design, data collection and analysis, edited and approved the final version of the article. DSB: funding acquisition, contributed to design of the study and data analysis, and approved the final version of the article. SC contributed to design of the study and data analysis and approved the final version of the article. All authors contributed to, and agreed the revisions following review

Declaration of Competing Interests: DSB, JMAS, SC, AoN declare no competing interests.

Ethics Statement: As a systematic review of the literature no ethical approval was required.

Funding: Health Education England (HEE) Wessex has provided financial support for a postgraduate student fellowship for 3 years [Ref HEE 19406-01].

Data availability statement: Data are available in a public, open access repository. All data supporting this study are openly available from the University of Southampton repository after thesis submission in July 2023 , as the work forms part of a PhD. Supplemental material. This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Figure 1: **PRISMA flow diagram of studies included in the review**

Supplementary material:

References

1. Hummel, S., et al., *Mental health among medical professionals during the COVID-19 pandemic in eight european countries: Cross-sectional survey study.* Journal of medical Internet research, 2021. **23**(1): p. e24983.
2. British Medical Association. *Caring for the Mental Health of Medical Workforce*. [Survey] 2019 October 2019; Available from: https://www.bma.org.uk/advice-and-support/nhs-delivery-and-workforce#workforce.
3. Imo, U.O., *Burnout and psychiatric morbidity among doctors in the UK: a systematic literature review of prevalence and associated factors.* BJPsych bulletin, 2017. **41**(4): p. 197-204.
4. Shanafelt, T.D., et al., *Burnout and self-reported patient care in an internal medicine residency program.* Annals of internal medicine, 2002. **136**(5): p. 358-367.
5. Halbesleben, J.R. and C. Rathert, *Linking physician burnout and patient outcomes: exploring the dyadic relationship between physicians and patients.* Health care management review, 2008. **33**(1): p. 29-39.
6. Shanafelt, T.D., et al., *Burnout and medical errors among American surgeons.* Annals of surgery, 2010. **251**(6): p. 995-1000.
7. West, C.P., et al., *Association of resident fatigue and distress with perceived medical errors.* Jama, 2009. **302**(12): p. 1294-1300.
8. General Medical Council *The state of medical education and practice in the UK*. 2019.
9. Royal College of Anaesthetists. *Respected, valued, retained: Working together to improve retention in anaesthesia*. 2021; Available from: https://www.rcoa.ac.uk/policy-communications/policy-public-affairs/anaesthesia-fit-future/improving-retention-anaesthesia.
10. Patel, R.S., et al., *A review on strategies to manage physician burnout.* Cureus, 2019. **11**(6).
11. Health Education England. *NHS Staff and Learners' Mental Wellbeing Commission*. 2019; Available from: www.hee.nhs.uk.
12. NHS. *WE ARE THE NHS: People Plan for 2020/2021 - action for us all*. 2020; Available from: https://www.england.nhs.uk/ournhspeople/.
13. British Medical Association. *BMA Fatigue and Facilities charter*. 2018; Available from: https://www.bma.org.uk/media/1076/bma-fatigue-and-facilities-charter_july2018.pdf.
14. West, M., & Coia, D. . *Caring for doctors, caring for patients*. 2019; Available from: https://www.gmc-uk.org/-/media/documents/caring-for-doctors-caring-for-patients_pdf-80706341.pdf.
15. NHS England & NHS Improvement. *NHS Health and Wellbeing Framework*. 2018; Available from: https://www.nhsemployers.org/publications/nhs-health-and-wellbeing-framework.
16. Chatfield, C. and A. Rimmer, *Give us a break*. 2019, British Medical Journal Publishing Group.

17. Tomkin, T. *Rest facilities improve for junior doctors*. 2020; Available from: https://www.bma.org.uk/news-and-opinion/rest-facilities-improve-for-junior-doctors.

18. Tucker, P., *The impact of rest breaks upon accident risk, fatigue and performance: a review.* Work & Stress, 2003. **17**(2): p. 123-137.

19. O'Neill A., et al., *The impact of intra-work rest breaks on doctors' performance and wellbeing: A systematic review*, in *PROSPERO*. 2020, PROSPERO: International prospective register of systematic reviews

20. Bramer, W.M., et al., *Optimal database combinations for literature searches in systematic reviews: a prospective exploratory study.* Systematic reviews, 2017. **6**(1): p. 1-12.

21. Sterne, J.A., et al., *RoB 2: a revised tool for assessing risk of bias in randomised trials.* bmj, 2019. **366**.

22. Sterne, J.A., et al., *ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions.* bmj, 2016. **355**.

23. Joanna Briggs Institute. *Critial Appraisal Tools*. 2020; Available from: https://jbi.global/critical-appraisal-tools.

24. Coburn, M., et al., *Influence of a 30-min break on divided attention and working memory in resident anaesthetists on daily routine.* BJA: British Journal of Anaesthesia, 2006. **97**(3): p. 315-319.

25. Mitra, B., et al., *Rest during shift work in the emergency department.* Australian Health Review, 2008. **32**(2): p. 246-251.

26. Amin, M.M., et al., *The effects of a mid-day nap on the neurocognitive performance of first-year medical residents: a controlled interventional pilot study.* Academic Medicine, 2012. **87**(10): p. 1428-1433.

27. Smith-Coggins, R., et al., *Improving alertness and performance in emergency department physicians and nurses: the use of planned naps.* Annals of emergency medicine, 2006. **48**(5): p. 596-604. e3.

28. Babbar, S., K.B. Williams, and A.-L. Cheng, *Sleep among Obstetrics and Gynecology Trainees: Results from a Yoga-Based Wellness Initiative.* American Journal of Perinatology, 2021.

29. Babbar, S., K. Renner, and K. Williams, *Addressing obstetrics and gynecology trainee burnout using a yoga-based wellness initiative during dedicated education time.* Obstetrics & Gynecology, 2019. **133**(5): p. 994-1001.

30. Ireland, M.J., et al., *A randomized controlled trial of mindfulness to reduce stress and burnout among intern medical practitioners.* Medical Teacher, 2017. **39**(4): p. 409-414.

31. Scheid, A., et al., *A yoga-based program decreases physician burnout in neonatologists and obstetricians at an academic medical center.* Workplace Health & Safety, 2020. **68**(12): p. 560-566.

32. Dorion, D. and S. Darveau, *Do micropauses prevent surgeon's fatigue and loss of accuracy associated with prolonged surgery? An experimental prospective study.* Journal of Vascular Surgery, 2013. **57**(4): p. 1173.

33. Engelmann, C., et al., *Effects of intraoperative breaks on mental and somatic operator fatigue: a randomized clinical trial.* Surgical endoscopy, 2011. **25**(4): p. 1245-1250.

34. Engelmann, C., et al., *Work breaks during minimally invasive surgery in children: patient benefits and surgeon's perceptions.* European journal of pediatric surgery, 2012. **22**(06): p. 439-444.

35. Hallbeck, M., et al., *The impact of intraoperative microbreaks with exercises on surgeons: a multi-center cohort study.* Applied ergonomics, 2017. **60**: p. 334-341.

36. Lemaire, J.B., et al., *Physician nutrition and cognition during work hours: effect of a nutrition based intervention.* BMC health services research, 2010. **10**(1): p. 1-9.

37. Mengin, A.C., et al., *Mindfulness Improves Otolaryngology Residents' Performance in a Simulated Bad-News Consultation: A Pilot Study.* Journal of Surgical Education, 2021. **78**(4): p. 1357-1365.

38. Al Dandan, O., et al., *Digital eye strain among radiologists: A survey-based cross-sectional study.* Academic Radiology, 2021. **28**(8): p. 1142-1148.

39. Winston, J., C. Johnson, and S. Wilson, *Barriers to healthy eating by National Health Service (NHS) hospital doctors in the hospital setting: results of a cross-sectional survey.* BMC research notes, 2008. **1**(1): p. 1-7.

40. Hassan, N.M., et al., *Job stress among resident physicians in Tanta University Hospitals, Egypt.* Environmental Science and Pollution Research, 2020. **27**(30): p. 37557-37564.

41. Kirkcaldy, B., R. Trimpop, and R. Levine, *The impact of work hours and schedules on the physical and psychological well-being in medical practices.* European Psychologist, 2002. **7**(2): p. 116.

42. Nitzsche, A., et al., *Recovery opportunities, work–home conflict, and emotional exhaustion among hematologists and oncologists in private practice.* Psychology, health & medicine, 2017. **22**(4): p. 462-473.

43. Kalboussi, H., et al. *Burnout Syndrome and its associated factors among Anesthesia Technicians in a Teaching Hospital in the central region of Tunisia*. in *Annales Medico-Psychologiques*. 2020. Masson Editeur, France.

44. Ohlander, J., et al., *Working conditions and effort–reward imbalance of German physicians in Sweden respective Germany: a comparative study.* International archives of occupational and environmental health, 2015. **88**(4): p. 511-519.

45. Bérastégui, P., et al., *Informal fatigue-related risk management in the emergency department: a trade-off between doing well and feeling well.* Safety science, 2020. **122**: p. 104508.

46. Hockey, P., et al., *Measuring the working experience of doctors in training.* Future Healthcare Journal, 2020. **7**(3): p. e17.

47. Neprash, H. and Barnett M.L., *Cognitive fatigue and opioid prescribing: Evidence from prescribing over the day and week.* Journal of General Internal Medicine, 2018. **33**(2, Suppl. 1, S142.).

48. Vosshenrich, J., et al., *Quantifying Radiology Resident Fatigue: Analysis of Preliminary Reports.* Radiology, 2021. **298**(3): p. 632-639.

49. Lemaire, J.B., et al., *Food for thought: an exploratory study of how physicians experience poor workplace nutrition.* Nutrition Journal, 2011. **10**(1): p. 1-8.

50. Lockhart, S., S. Jamal, and K. Shojania, *Regular Physical Exercise Incorporated into a Rheumatology Fellowship Curriculum: A Qualitative Survey of Participants.* Journal of Rheumatology, 2013. **40**(6): p. 1014-1014.

51. Hall, L.H., et al., *Strategies to improve general practitioner well-being: findings from a focus group study.* Family practice, 2018. **35**(4): p. 511-516.

52. Morrow, G., et al., *Have restricted working hours reduced junior doctors' experience of fatigue? A focus group and telephone interview study.* BMJ open, 2014. **4**(3): p. e004222.

53. O'Shea, J., et al., *"Breaking" the Emergency Department: Does the Culture of Emergency Medicine Present a Barrier to Self-Care?* Western Journal of Emergency Medicine, 2020. **21**(2): p. 313.

54. Walsh, A., et al., *Motherhood during residency training: challenges and strategies.* Canadian Family Physician, 2005. **51**(7): p. 990-991.

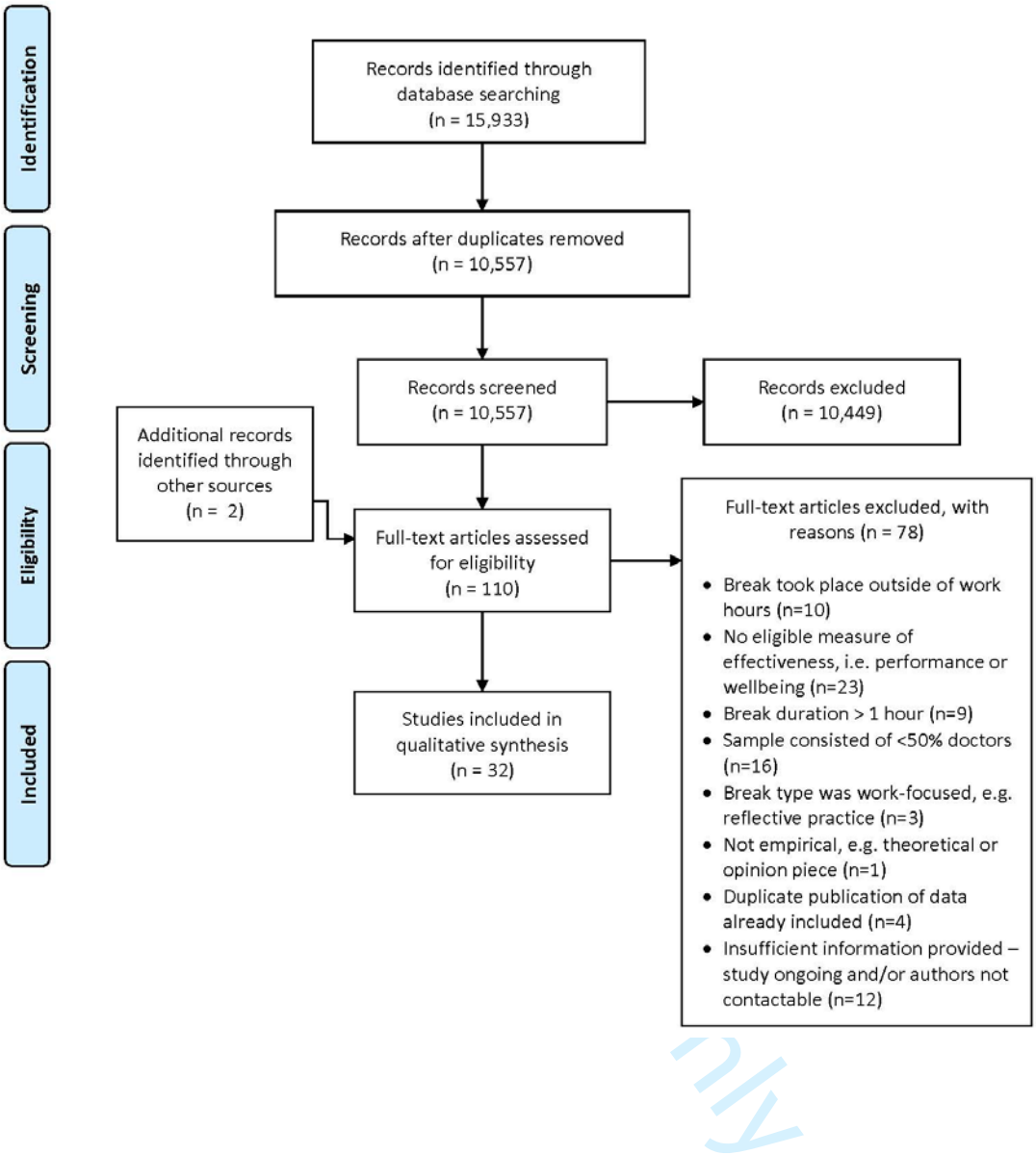
55. Wilkesmann, M., *Ignorance management in hospitals.* VINE Journal of Information and Knowledge Management Systems, 2016. **46**(4): p. 430-449.

56. Simons, G. and D.S. Baldwin, *A critical review of the definition of 'wellbeing'for doctors and their patients in a post Covid-19 era.* International Journal of Social Psychiatry, 2021. **67**(8): p. 984-991.

57. Brady, K.J., et al., *What do we mean by physician wellness? A systematic review of its definition and measurement.* Academic Psychiatry, 2018. **42**(1): p. 94-108.

58. Dyrbye, L.N., et al., *A pragmatic approach for organizations to measure health care professional well-being.* NAM Perspectives, 2018.

Figure 1 PRISMA flow diagram of studies included in the review



Based on: 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(7): e1000097. doi:10.1371/journal.pmed1000097

Supplementary material: Contents:

Supplementary material: Abbreviations

N.S	Not significant/not significantly/non-significant
EEG	Electroencephalogram
BS	Before shift
PI	Post intervention
AS	After shift
IV	Intravenous
ED	Emergency department
EM	Emergency medicine
IM	Internal medicine
M/F	Male/Female
ENT	Ear nose and throat
GP	General Practitioner
No.	Number

Supplementary material: Search strategy

Ovid Embase Classic + Embase 1947 – 2021 June 06

1	exp physician/ OR exp resident/
2	(doctor* OR physician* OR resident*).ab,ti
3	#1 OR #2
4	exp rest/
5	(break OR breakroom OR breaks OR break-time OR break-taking OR doctors mess OR micro-break* OR microbreak* OR nap OR napping OR naps OR rest OR rest-break* OR restful OR resting OR sleep OR sleeping OR work-break*).ab,ti
6	#4 OR #5
7	exp "occupation and occupation related phenomena"/
8	(duty OR duties OR employee* OR employment OR internship* OR job OR jobs OR occupation* OR on-call OR on-shift OR organisation* OR organization* OR profession* OR rotation* OR rota* OR shift OR shifts OR shift-work OR shift-working OR staff OR work OR workday* OR work environment* OR worker* OR workforce OR working OR workload OR workplace OR work-related).ab,ti
9	#7 OR #8
10	#3 AND #6 AND #9
11	exp health/ OR exp wellbeing/ OR exp occupational health/ OR exp medical error/ OR exp work/ OR exp occupational science/
12	(absenteeism OR anxiety OR anxious OR burnout OR depression OR depressive OR employee health OR exhaustion OR fatigue OR mental health OR musculoskeletal OR occupational health OR occupational disease* OR occupational injury OR occupational injuries OR presenteeism OR quality of life OR recovery OR resilience OR resiliency OR sick note* OR sickness absence* OR sickness leave OR sick leave OR sleepiness OR staff absence* OR staff leave OR stress OR tiredness OR turnover OR wakefulness OR well-being OR wellbeing OR well being OR wellness OR well-ness OR work absence*).ab,ti
13	(ability to concentrate OR adverse event* OR alertness OR appraisal* OR assess* performance OR care quality OR claim* by patient* OR care of patient* OR care for patient* OR clinical performance OR clinical outcome* OR competen* at work OR concentration OR consultation satisfaction OR deadline* OR death rate* OR feedback OR fit* to practice OR fit* to practise OR decision-making OR decision making OR industrial safety OR industrial health OR infection rate* OR job dedication OR job effectiveness OR job efficiency OR job engagement OR job motivation OR job performance OR job satisfaction OR job skill* OR job productivity OR medical error* OR medical mistake* OR medical negligenc* OR meet* objective* OR mental acuity OR occupational safety OR organisational citizenship OR organizational citizenship OR patient care OR patient complaint* OR patient claim* OR patient death* OR patient outcome* OR patient mortality OR patient satisfaction OR patient wait* time* OR perform task* OR performance assess* OR prevention uptake rate* OR quality of work OR quality of care OR quality indicat* OR quality of service OR reaction speed* OR reaction time* OR readmission* rate* OR referral rate* OR revalidation OR service provision OR significant event* OR standard* of care OR surgery rate* OR target* OR task performance OR teamwork OR treatment outcome* OR wait* list* OR wait* time* OR work capacity OR working effectively OR working efficiently OR work engagement OR work performance OR work productivity OR work quality).ab,ti
14	("friends and family test*").ab,ti
15	#11 OR #12 OR #13 OR #14
16	#10 AND #15

PubMed

1	physician [MeSH] OR “Internship and Residency”[MeSH]
2	doctor*[Title/Abstract] OR physician*[Title/Abstract] OR resident* [Title/Abstract]
3	#1 OR #2
4	"rest"[MeSH]
5	break[Title/Abstract] OR breakroom[Title/Abstract] OR breaks OR breaktime[Title/Abstract] OR break-taking[Title/Abstract] OR “doctors mess”[Title/Abstract] OR “doctor’s mess”[Title/Abstract] OR micro-break*[Title/Abstract] OR microbreak*[Title/Abstract] OR nap[Title/Abstract] OR napping[Title/Abstract] OR naps[Title/Abstract] OR rest[Title/Abstract] OR rest-break*[Title/Abstract] OR restful[Title/Abstract] OR resting[Title/Abstract] OR sleep[Title/Abstract] OR sleeping[Title/Abstract] OR work-break*[Title/Abstract]
6	#4 OR #5
7	work[MeSH] OR workplace[MeSH]
8	duty[Title/Abstract] OR duties[Title/Abstract] OR employee*[Title/Abstract] OR employment[Title/Abstract] OR internship*[Title/Abstract] OR job[Title/Abstract] OR jobs[Title/Abstract] OR occupation*[Title/Abstract] OR on-call[Title/Abstract] OR on-shift[Title/Abstract] OR organisation*[Title/Abstract] OR organization*[Title/Abstract] OR profession*[Title/Abstract] OR rotation*[Title/Abstract] OR rota*[Title/Abstract] OR shift[Title/Abstract] OR shifts[Title/Abstract] OR shift-work[Title/Abstract] OR shift-working[Title/Abstract] OR staff[Title/Abstract] OR work[Title/Abstract] OR workday*[Title/Abstract] OR “work environment*”[Title/Abstract] OR worker* OR workforce[Title/Abstract] OR working[Title/Abstract] OR workload[Title/Abstract] OR workplace[Title/Abstract] OR work-related[Title/Abstract]
9	#7 OR #8
10	#3 AND #6 AND #9
11	“occupational health”[MeSH] OR “mental health”[MeSH] OR “medical errors”[MeSH] OR “work performance”[MeSH]
12	absenteeism[Title/Abstract] OR anxiety[Title/Abstract] OR anxious[Title/Abstract] OR burnout[Title/Abstract] OR depression[Title/Abstract] OR depressive[Title/Abstract] OR employee health[Title/Abstract] OR exhaustion[Title/Abstract] OR fatigue[Title/Abstract] OR mental health[Title/Abstract] OR musculoskeletal[Title/Abstract] OR occupational health[Title/Abstract] OR occupational disease*[Title/Abstract] OR occupational injury[Title/Abstract] OR occupational injuries[Title/Abstract] OR presenteeism[Title/Abstract] OR quality of life[Title/Abstract] OR recovery[Title/Abstract] OR resilience[Title/Abstract] OR resiliency[Title/Abstract] OR sick note*[Title/Abstract] OR sickness absence*[Title/Abstract] OR sickness leave[Title/Abstract] OR sick leave[Title/Abstract] OR sleepiness[Title/Abstract] OR staff absence*[Title/Abstract] OR staff leave[Title/Abstract] OR stress[Title/Abstract] OR tiredness[Title/Abstract] OR turnover[Title/Abstract] OR wakefulness[Title/Abstract] OR well-being[Title/Abstract] OR wellbeing[Title/Abstract] OR well being[Title/Abstract] OR wellness[Title/Abstract] OR well-ness[Title/Abstract] OR work absence*[Title/Abstract]
13	ability to concentrate[Title/Abstract] OR adverse event*[Title/Abstract] OR alertness[Title/Abstract] OR appraisal*[Title/Abstract] OR assess* performance[Title/Abstract] OR care quality[Title/Abstract] OR claim* by patient*[Title/Abstract] OR care of patient*[Title/Abstract] OR care for patient*[Title/Abstract] OR clinical performance[Title/Abstract] OR clinical outcome*[Title/Abstract] OR competen* at work[Title/Abstract] OR concentration[Title/Abstract] OR consultation satisfaction[Title/Abstract] OR deadline*[Title/Abstract] OR death rate*[Title/Abstract] OR feedback[Title/Abstract] OR fit* to practice[Title/Abstract] OR fit* to practise[Title/Abstract] OR decision-making[Title/Abstract] OR decision making[Title/Abstract] OR industrial safety[Title/Abstract] OR industrial health[Title/Abstract] OR infection rate*[Title/Abstract] OR job dedication[Title/Abstract] OR job effectiveness[Title/Abstract] OR job efficiency[Title/Abstract] OR job engagement[Title/Abstract] OR job motivation[Title/Abstract] OR job

	performance[Title/Abstract] OR job satisfaction[Title/Abstract] OR job skill*[Title/Abstract] OR job productivity[Title/Abstract] OR medical error*[Title/Abstract] OR medical mistake*[Title/Abstract] OR medical negligenc*[Title/Abstract] OR meet* objective*[Title/Abstract] OR mental acuity[Title/Abstract] OR occupational safety[Title/Abstract] OR organisational citizenship[Title/Abstract] OR organizational citizenship[Title/Abstract] OR patient care[Title/Abstract] OR patient complaint*[Title/Abstract] OR patient claim*[Title/Abstract] OR patient death*[Title/Abstract] OR patient outcome*[Title/Abstract] OR patient mortality[Title/Abstract] OR patient satisfaction[Title/Abstract] OR patient wait* time*[Title/Abstract] OR perform task*[Title/Abstract] OR performance assess*[Title/Abstract] OR prevention uptake rate*[Title/Abstract] OR quality of work[Title/Abstract] OR quality of care[Title/Abstract] OR quality indicat*[Title/Abstract] OR quality of service[Title/Abstract] OR reaction speed*[Title/Abstract] OR reaction time*[Title/Abstract] OR readmission* rate*[Title/Abstract] OR referral rate*[Title/Abstract] OR revalidation[Title/Abstract] OR service provision[Title/Abstract] OR significant event*[Title/Abstract] OR standard* of care[Title/Abstract] OR surgery rate*[Title/Abstract] OR target*[Title/Abstract] OR task performance[Title/Abstract] OR teamwork[Title/Abstract] OR treatment outcome*[Title/Abstract] OR wait* list*[Title/Abstract] OR wait* time*[Title/Abstract] OR work capacity[Title/Abstract] OR working effectively[Title/Abstract] OR working efficiently[Title/Abstract] OR work engagement[Title/Abstract] OR work performance[Title/Abstract] OR work productivity[Title/Abstract] OR work quality[Title/Abstract] OR “friends and family test*”[Title/Abstract]
14	#11 OR #12 OR #13
15	#10 AND #14

Web of Science

	(Topic search selected)
1	doctor* OR physician* OR resident*
2	break OR breakroom OR breaks OR “break-time” OR “break-taking” OR “doctors mess” OR “micro-break*” OR microbreak* OR nap OR napping OR naps OR rest OR “rest-break*” OR restful OR resting OR sleep OR sleeping OR “work-break*”
3	duty OR duties OR employee* OR employment OR internship* OR job OR jobs OR occupation* OR “on-call” OR “on-shift” OR organisation* OR organization* OR profession* OR rotation* OR rota* OR shift OR shifts OR “shift-work” OR “shift-working” OR staff OR work OR workday* OR “work environment*” OR worker* OR workforce OR working OR workload OR workplace OR “work-related”
4	#1 AND #2 AND #3 = 5,854
5	#5 absenteeism OR anxiety OR anxious OR burnout OR depression OR depressive OR “employee health” OR exhaustion OR fatigue OR “mental health” OR musculoskeletal OR “occupational health” OR “occupational disease*” OR “occupational injury” OR “occupational injuries” OR presenteeism OR “quality of life” OR recovery OR resilience OR resiliency OR “sick note*” OR “sickness absence*” OR “sickness leave” OR “sick leave” OR sleepiness OR “staff absence*” OR “staff leave” OR stress OR tiredness OR turnover OR wakefulness OR “well-being” OR wellbeing OR “well being” OR wellness OR “well-ness” OR “work absence*”
6	“ability to concentrate” OR “adverse event*” OR alertness OR appraisal* OR “assess* performance” OR “care quality” OR “claim* by patient*” OR “care of patient*” OR “care for patient*” OR “clinical performance” OR “clinical outcome*” OR “competen* at work” OR concentration OR “consultation satisfaction” OR deadline* OR “death rate*” OR “decision-making” OR “decision making” OR feedback OR “fit* to practice” OR “fit* to practise” OR “friends and family test*” OR “industrial safety” OR “industrial health” OR “infection rate*” OR “job dedication” OR “job effectiveness” OR “job efficiency” OR “job engagement” OR “job motivation” OR “job performance” OR “job satisfaction” OR “job skill*” OR “job productivity” OR “medical error*” OR “medical mistake*” OR “medical negligenc*” OR “meet* objective*” OR “mental acuity” OR “occupational safety” OR “organisational citizenship” OR “organizational citizenship” OR “patient care” OR “patient complaint*” OR “patient claim*” OR “patient death*” OR “patient outcome*” OR “patient mortality”

	OR “patient satisfaction” OR “patient wait* time*” OR “perform task*” OR “performance assess*” OR “prevention uptake rate*” OR “quality of work” OR “quality of care” OR “quality indicat*” OR “quality of service” OR “reaction speed*” OR “reaction time*” OR “readmission* rate*” OR “referral rate*” OR revalidation OR “service provision” OR “significant event*” OR “standard* of care” OR “surgery rate*” OR target* OR “task performance” OR teamwork OR “treatment outcome*” OR “wait* list*” OR “wait* time*” OR “work capacity” OR “working effectively” OR “working efficiently” OR “work engagement” OR “work performance” OR “work productivity” OR “work quality”
7	#5 OR #6
8	#4 AND #7

PsycINFO

1	DE "Physicians" OR DE "Family Physicians" OR DE "General Practitioners" OR DE "Gynecologists" OR DE "Internists" OR DE "Neurologists" OR DE "Obstetricians" OR DE "Pathologists" OR DE "Pediatricians" OR DE "Psychiatrists" OR DE "Surgeons" OR DE “medical residency” OR DE “medical internship”
2	TI doctor* OR TI physician* OR AB doctor* OR AB physician* OR TI resident* OR AB resident*
3	S1 OR S2
4	DE "Relaxation" OR DE "Work Rest Cycles"
5	TI break OR TI breakroom OR TI breaks OR TI “break-time” OR TI “break-taking” OR TI “doctors mess” OR TI “micro-break*” OR TI microbreak* OR TI nap OR TI napping OR TI naps OR TI rest OR TI “rest-break*” OR TI restful OR TI resting OR TI sleep OR TI sleeping OR TI “work-break*” OR AB break OR AB breakroom OR AB breaks OR AB “break-time” OR AB “break-taking” OR AB “doctors mess” OR AB “micro-break*” OR AB microbreak* OR AB nap OR AB napping OR AB naps OR AB rest OR AB “rest-break*” OR AB restful OR AB resting OR AB sleep OR AB sleeping OR AB “work-break*”
6	S4 OR S5
7	#DE "Working Conditions" OR "Workday Shifts" OR DE "Working Space"
8	TI duty OR TI duties OR TI employee* OR TI employment OR TI internship* OR TI job OR TI jobs OR TI occupation* OR TI “on-call” OR TI “on-shift” OR TI organisation* OR TI organization* OR TI profession* OR TI rotation* OR TI rota* OR TI shift OR TI shifts OR TI “shift-work” OR TI “shift-working” OR TI staff OR TI work OR TI workday* OR TI “work environment*” OR TI worker* OR TI workforce OR TI working OR TI workload OR TI workplace OR TI “work-related” OR AB duty OR AB duties OR AB employee* OR AB employment OR AB internship* OR AB job OR AB jobs OR AB occupation* OR AB “on-call” OR AB “on-shift” OR AB organisation* OR AB organization* OR AB profession* OR AB rotation* OR AB rota* OR AB shift OR AB shifts OR AB “shift-work” OR AB “shift-working” OR AB staff OR AB work OR AB workday* OR AB “work environment*” OR AB worker* OR AB workforce OR AB working OR AB workload OR AB workplace OR AB “work-related”
9	S7 OR S8
10	S3 AND S6 AND S9 = 1,702
11	DE "Health Status" OR DE "Health Literacy" OR DE "Health Outcomes" OR DE "Mental Health" OR DE "Occupational Health" OR DE "Physical Health" OR DE "Well Being" OR DE "Spiritual Well Being" OR DE "Errors" OR DE "Patient Safety" OR DE "Job Performance" OR DE "Employee Efficiency" OR DE "Employee Productivity" OR DE "Job Satisfaction"
12	TI absenteeism OR TI anxiety OR TI anxious OR TI burnout OR TI depression OR TI depressive OR TI “employee health” OR TI exhaustion OR TI fatigue OR TI “mental health” OR TI musculoskeletal OR TI “occupational health” OR TI “occupational disease*” OR TI “occupational injury” OR TI “occupational injuries” OR TI presenteeism OR TI “quality of life” OR TI recovery OR TI resilience OR TI resiliency OR TI “sick note*” OR TI “sickness absence*” OR TI “sickness leave” OR TI “sick leave” OR TI sleepiness OR TI “staff absence*” OR TI “staff leave” OR TI stress OR TI tiredness OR TI turnover OR TI wakefulness OR TI “well-being” OR TI wellbeing OR TI “well being” OR TI wellness OR TI “well-ness” OR TI “work absence*” OR AB absenteeism OR AB anxiety OR AB anxious OR AB burnout OR AB

	depression OR AB depressive OR AB "employee health" OR AB exhaustion OR AB fatigue OR AB "mental health" OR AB musculoskeletal OR AB "occupational health" OR AB "occupational disease*" OR AB "occupational injury" OR AB "occupational injuries" OR AB presenteeism OR AB "quality of life" OR AB recovery OR AB resilience OR AB resiliency OR AB "sick note*" OR AB "sickness absence*" OR AB "sickness leave" OR AB "sick leave" OR AB sleepiness OR AB "staff absence*" OR AB "staff leave" OR AB stress OR AB tiredness OR AB turnover OR AB wakefulness OR AB "well-being" OR AB wellbeing OR AB "well being" OR AB wellness OR AB "well-ness" OR AB "work absence*"
13	TI "ability to concentrate" OR TI "adverse event*" OR TI alertness OR TI appraisal* OR TI "assess* performance" OR TI "care quality" OR TI "claim* by patient*" OR TI "care of patient*" OR TI "care for patient*" OR TI "clinical performance" OR TI "clinical outcome*" OR TI "competen* at work" OR TI concentration OR TI "consultation satisfaction" OR TI deadline* OR TI "death rate*" OR TI "decision-making" OR TI "decision making" OR TI feedback OR TI "fit* to practice" OR TI "fit* to practise" OR TI "friends and family test*" OR TI "industrial safety" OR TI "industrial health" OR TI "infection rate*" OR TI "job dedication" OR TI "job effectiveness" OR TI "job efficiency" OR TI "job engagement" OR TI "job motivation" OR TI "job performance" OR TI "job satisfaction" OR TI "job skill*" OR TI "job productivity" OR TI "medical error*" OR TI "medical mistake*" OR TI "medical negligenc*" OR TI "meet* objective*" OR TI "mental acuity" OR TI "occupational safety" OR TI "organisational citizenship" OR TI "organizational citizenship" OR TI "patient care" OR TI "patient complaint*" OR TI "patient claim*" OR TI "patient death*" OR TI "patient outcome*" OR TI "patient mortality" OR TI "patient satisfaction" OR TI "patient wait* time*" OR TI "perform task*" OR TI "performance assess*" OR TI "prevention uptake rate*" OR TI "quality of work" OR TI "quality of care" OR TI "quality indicat*" OR TI "quality of service" OR TI "reaction speed*" OR TI "reaction time*" OR TI "readmission* rate*" OR TI "referral rate*" OR TI revalidation OR TI "service provision" OR TI "significant event*" OR TI "standard* of care" OR TI "surgery rate*" OR TI target* OR TI "task performance" OR TI teamwork OR TI "treatment outcome*" OR TI "wait* list*" OR TI "wait* time*" OR TI "work capacity" OR TI "work* effectively" OR TI "work* efficiently" OR TI "work engagement" OR TI "work performance" OR TI "work productivity" OR TI "work quality" OR AB "ability to concentrate" OR AB "adverse event*" OR AB alertness OR AB appraisal* OR AB "assess* performance" OR AB "care quality" OR AB "claim* by patient*" OR AB "care of patient*" OR AB "care for patient*" OR AB "clinical performance" OR AB "clinical outcome*" OR AB "competen* at work" OR AB concentration OR AB "consultation satisfaction" OR AB deadline* OR AB "death rate*" OR AB "decision-making" OR AB "decision making" OR AB feedback OR AB "fit* to practice" OR AB "fit* to practise" OR AB "friends and family test*" OR AB "industrial safety" OR AB "industrial health" OR AB "infection rate*" OR AB "job dedication" OR AB "job effectiveness" OR AB "job efficiency" OR AB "job engagement" OR AB "job motivation" OR AB "job performance" OR AB "job satisfaction" OR AB "job skill*" OR AB "job productivity" OR AB "medical error*" OR AB "medical mistake*" OR AB "medical negligenc*" OR AB "meet* objective*" OR AB "mental acuity" OR AB "occupational safety" OR AB "organisational citizenship" OR AB "organizational citizenship" OR AB "patient care" OR AB "patient complaint*" OR AB "patient claim*" OR AB "patient death*" OR AB "patient outcome*" OR AB "patient mortality" OR AB "patient satisfaction" OR AB "patient wait* time*" OR AB "perform task*" OR AB "performance assess*" OR AB "prevention uptake rate*" OR AB "quality of work" OR AB "quality of care" OR AB "quality indicat*" OR AB "quality of service" OR AB "reaction speed*" OR AB "reaction time*" OR AB "readmission* rate*" OR AB "referral rate*" OR AB revalidation OR AB "service provision" OR AB "significant event*" OR AB "standard* of care" OR AB "surgery rate*" OR AB target* OR AB "task performance" OR AB teamwork OR AB "treatment outcome*" OR AB "wait* list*" OR AB "wait* time*" OR AB "work capacity" OR AB "work* effectively" OR AB "work* efficiently" OR AB "work engagement" OR AB "work performance" OR AB "work productivity" OR AB "work quality"
14	#11 OR #12 OR #13
15	#10 AND #14

Availability of all data collection forms, data extracted from included studies hosted on University of Southampton Website, and available on request

Supplementary Table 1. Rationale for observational cohort risk of bias assessments (JBI)

Study: Bérastégui (2020)[45]		**Study:** Hockey (2020)[46]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	No control/ comparison group	Q1	No control/ comparison group
Q2	No control/ comparison group	Q2	No control/ comparison group
Q3	Study specific qualitative tool (list of fatigue reduction strategies), validity unclear. Not objective.	Q3	Time spent on task (breaks). Objective and reliably measured.
Q4	No mention of covariates, no confounders identified.	Q4	Analysis controlled for demographic data, time at which the task (breaks) was performed and the minutes since it was started.
Q5	Model allowed control of variance from random factors	Q5	
Q6	Participants not free of outcomes prior to study commencement	Q6	Participants not free of outcomes prior to study commencement
Q7	Validity of outcomes unclear. However, measured in a reliable way	Q7	Validation studies completed showing acceptable validity
Q8	Several repeated measurements of reaction time (sufficient). Burnout measured once at baseline.	Q8	5x 2-hour periods selected across shifts (sufficient).
Q9	Authors mention there was staff turnover and new participants recruited but unclear whether this affected follow-up of the longitudinal variables	Q9	All survey responses included, regardless of quantity of surveys completed. When incomplete task data was excluded, other data from survey included.
Q10		Q10	
Q11	Statistics appear appropriate for data	Q11	Statistics appear appropriate for data
Study: Neprash (2018)[47]		**Study:** Vosshenrich (2021)[48]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	No control/ comparison group	Q1	No control/ comparison group
Q2	No control/ comparison group	Q2	No control/ comparison group
Q3	Objective and reliably measured. (Gap of >15 minutes in schedule)	Q3	Method of defining breaks does not appear reliable. Authors assume 45-min breaks taken before/after teaching at noon, when staff overlap on weekend

			shifts, and inconsistently on night shifts. Then split data into 2-hour blocks (10:00-11:59am, 12-1:59pm, etc.) and approximate reports which might be close to lunch times.
Q4	Analysis controlled for demographic characteristics, visit characteristics and differences across physicians	Q4	Proofreading behaviour consistency among staff was analysed (potential confounder). State that inclusion of a large number of cross-sectional imaging studies might exacerbate decreases in mean report similarity
Q5		Q5	Impact of cross-sectional imaging identified as confounder but not considered in analysis. Proofreading consistency over course of a day (e.g. morning vs afternoon) assumed.
Q6	Participants not free of outcome prior to study commencement	Q6	Participants not free of outcome prior to study commencement
Q7	Objective and reliable measurement (of inappropriate opioid prescription).	Q7	Objective, reliable. (Jaccard similarity coefficient)
Q8	12-month period (sufficient)	Q8	2.5 year period (sufficient).
Q9	Not applicable to retrospective cohort studies	Q9	Not applicable to retrospective cohort studies
Q10	Not applicable to retrospective cohort studies	Q10	Not applicable to retrospective cohort studies
Q11	Statistics appear appropriate for data	Q11	Statistics appear appropriate for data

Supplementary Table 2. Rationale for cross-sectional risk of bias assessments (JBI)

Study: Al Dandan (2020)[38]		**Study:** Hassan (2020)[40]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	Inclusion criteria defined	Q1	Inclusion criteria defined
Q2	Subjects described in adequate detail	Q2	Subjects described in adequate detail
Q3	Break frequency and duration measured using arbitrary study-specific time categories.	Q3	The original, validated survey does not include questions about breaks. This is an additional component without psychometric data.
Q4		Q4	
Q5	Confounding factors identified	Q5	No confounders identified
Q6	Confounders not dealt with statistically. Used multivariate logistic regression but it did not account for certain inherent confounders (e.g. mobile usage and type of corrective lenses)	Q6	
Q7	Although eye strain not diagnosed objectively, scale used was tested for face validity etc.	Q7	Stress as outcome measurement on the original HCJSSQ is validated.
Q8	Statistics appear appropriate for data	Q8	Statistics appear appropriate for data
Study: Kalboussi (2020)[43]		**Study:** Kirkcaldy (2002)[41]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	Inclusion criteria defined	Q1	Inclusion criteria defined
Q2	Subjects described in adequate detail	Q2	Subjects described in adequate detail
Q3	Breaks measured as dichotomised yes/no variable. Not clear how this was measured or defined.	Q3	Break duration measured as time of break onset and time of break cessation. Appears objective and reliable.
Q4		Q4	
Q5	Confounders identified	Q5	Confounders identified and methods (e.g. recruitment, statistics) were used to control for these.
Q6	Analysis does not appear to take confounders into account	Q6	
Q7	Used validated measures of burnout	Q7	Criterion validity measured/established for the measure of stress
Q8	Only description for analyses was ‘univariate analysis’	Q8	Statistics appear appropriate for data

Study: Nitszche (2017)[42]		**Study:** Ohlander (2015)[44]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	Inclusion criteria defined	Q1	Inclusion criteria defined
Q2	Subjects described in adequate detail	Q2	Subjects described in adequate detail
Q3	Study-specific single question on recovery opportunities with Likert-type rating. Not validated, not objective or standardised measure.	Q3	Breaks measured in minutes per day. Appears objective and reliable.
Q4		Q4	
Q5	Confounders identified in limitations	Q5	Confounders identified
Q6	While SEM and multivariate equations should account for confounders, it appears the author did not put these into the equation.	Q6	Statistics accounted for apriori confounders.
Q7	Burnout, work-home conflict and home-work conflict measured using established, validated and reliable measures	Q7	Work stress measured on validated effort-reward imbalnce questionnaire
Q8	Statistics appear appropriate for data	Q8	Statistics appear appropriate for data
Study: Winston (2008)[39]			
No.	**Additional comments**		
Q1	Inclusion criteria defined		
Q2	Subjects described in adequate detail		
Q3	Not clear how break prevalence was measured. Lack of breaks listed as an option on a checklist of barriers to healthy eating.		
Q4	Does not appear to be validated or objective.		
Q5	Confounders identified		
Q6	Variables that could affect healthy eating are descriptively measured but break-taking analyses do not appear to account for confounding factors		
Q7	Study specific questionnaire used to select perceived barriers		
Q8	Statistics appear appropriate for data		

Supplementary Table 3. Rationale for qualitative risk of bias assessments (JBI)

Study: Hall (2018)[51]		**Study:** Lemaire (2011)[49]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	Philosophical perspective and methodology congruent	Q1	Unknown - No statement about philosophical or theoretical perspective
Q2	Methodology and research objectives congruent	Q2	Methodology and research objectives congruent
Q3	Methodology and methods congruent	Q3	Methodology and methods congruent
Q4	Methodology and analysis congruent	Q4	Methodology and analysis congruent
Q5	Methodology and interpretation congruent	Q5	Methodology and interpretation congruent
Q6	Partially. Acknowledges "the first author's realist epistemological approach".	Q6	Acknowledges that interviewer was female internal medicine consultant, clinical professor, a colleague, and Vice Chair of Physician Wellness and Vitality
Q7	No mention of implications of above (Q6)	Q7	No mention of implications of above (Q6)
Q8	Voices of participants adequately represented	Q8	Voices of participants adequately represented
Q9	Ethical approval granted	Q9	Ethical approval granted
Q10	Conclusions appropriate	Q10	Conclusions appropriate
Study: Lockhart (2013)[50]		**Study:** Morrow (2014)[52]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	Unknown - No statement about philosophical or theoretical perspective	Q1	Unknown - No statement about philosophical or theoretical perspective
Q2	Methodology and research objectives congruent	Q2	Methodology and research objectives congruent
Q3	Methodology and methods congruent	Q3	Methodology and methods congruent
Q4	Methodology and analysis congruent	Q4	Methodology and analysis congruent
Q5	Methodology and interpretation congruent	Q5	Methodology and interpretation congruent
Q6	No statement about the researchers' cultural or theoretical perspectives	Q6	No statement about the researchers' cultural or theoretical perspectives

Q7	While an anonymous survey was used and researcher shouldn't theoretically have an influence, there were only 5 participants in the intervention so it is potentially more open to influence. Unclear from abstract information alone if this could affect results.	Q7	Influence of researcher not addressed
Q8	Unknown - Insufficient information in the abstract	Q8	Voices of participants adequately represented
Q9	Unknown - Insufficient information in the abstract	Q9	Ethical approval granted
Q10	Conclusions appropriate	Q10	Conclusions appropriate
Study: O'Shea (2020)[53]		**Study:** Walsh (2005)[54]	
No.	**Additional comments**	**No.**	**Additional comments**
Q1	Unknown - No statement about philosophical or theoretical perspective	Q1	Unknown - No statement about philosophical or theoretical perspective
Q2	Methodology and research objectives congruent	Q2	Methodology and research objectives congruent
Q3	Methodology and methods congruent	Q3	Methodology and methods congruent
Q4	Methodology and analysis congruent	Q4	Methodology and analysis congruent
Q5	Methodology and interpretation congruent	Q5	Methodology and interpretation congruent
Q6	No statement about the researchers' cultural or theoretical perspectives	Q6	No statement about the researchers' cultural or theoretical perspectives
Q7	Explains that faculty members known by participants were moderators for focus groups which could have influenced their answers	Q7	Influence of researcher not addressed
Q8	Voices of participants adequately represented	Q8	Voices of participants adequately represented
Q9	Ethical approval granted	Q9	Ethical approval granted
Q10	Conclusions appropriate	Q10	Conclusions appropriate
Study: Wilkesmann (2016)[55]			
No.	**Additional comments**		
Q1	Lots of theoretical context in the introduction (e.g. known unknowns, known knowns etc.) but no statement of philosophical perspective		
Q2	Methodology and research objectives congruent		

Q3	Methodology and methods congruent		
Q4	Methodology and analysis congruent		
Q5	Methodology and interpretation congruent		
Q6	No statement about the researchers' cultural or theoretical perspectives		
Q7	Influence of researcher not addressed		
Q8	While the qualitative data does show some evidence of quotes for the two overarching themes (hiding ignorance and sharing ignorance) there is not much evidence of participant voices in the hypotheses building		
Q9	Unknown – statement about ethical approvals not given		
Q10	Conclusions appropriate		

Supplementary Table 4: Summary of Included Studies

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
QUANTITATIVE STUDIES					
Standard 30-min break interventions					
Coburn (2006)[24] Germany Published report	Double blind randomised cross-over trial. Min. 28 days between phases	N=30 anaesthesia trainee doctors; 63.3% M	30-min breaks in a recreation room vs no break during 7.5 hr shifts	*Measured at 7:30 and 14:00:* 1) Test for Attentional Performance 2) Stanford Sleepiness Scale 3) State-Trait Anxiety Inventory	N.S difference between break or control on divided attention, working memory, sleepiness or self-reported anxiety
Mitra (2008) [25] Australia Published report	Before-and-after study over 4-week period (2-wk baseline phase, 2-wk intervention phase)	N=121 baseline and N=112 post-intervention surveys from ED doctors of all grades; M/F ratio not reported	Baseline/usual practice phase vs promotion of 30-min uninterrupted breaks (facilitated by cover doctor, educational sessions and posters)	*Completed at the end of every shift:* 1) Number of breaks and duration 2) Visual analogue tiredness rating 3) Fatigue Severity Scale 4) Routine departmental performance indicators	1) Break-taking improved from 33% to 60% 2) Subjective tiredness at end of shift lower when break taken (p<.001) 3) Reduction in objective fatigue levels at end of shift when break taken (p=.065) 4) Departmental performance indicators (e.g. triage time, time to be seen) improved (p<.001)
Sleep-related interventions					
Amin (2012) [26] USA Published report	Cluster non-randomised controlled trial. Single-day protocol. Intervention and control 1 yr apart	N=29 1st year medicine trainees; n=19 intervention, n=11 control; 58.6% M	20-min midday naps in a recliner chair during daytime shifts vs controls who lay in chair but conversed with researcher for 20 min	*Measured before and after intervention:* 1) Conner's Continuous Performance Test (CPTII) 2) Attentional failures (EEG) 3) Average sleep duration during intervention	1) Cognitive functioning improved in nap group compared with control (Hit reaction time p=.004; Omission rate p=.01; Commission rate p=.007) 2) Attentional failures decreased in nap group and increased in control group (p=.002) 3) 8.4 +/- 3 mins
Smith-Coggins (2006) [27] USA Published report	RCT. 2-day protocol: baseline shift and shift with intervention	N=49 ED staff (n=25 doctors, n=24 nurses); n=26 intervention, n=23 control; 32.7% M	40-min nap opportunity at 3AM during a 12-hr night shift vs continued work	*Measured before shift (BS-6:30pm), post-intervention (PI-4am) and after shift (AS-7:30am) on baseline and intervention day:* 1) Psychomotor Vigilance Task 2) Probe Recall Memory Task 3) IV simulation (CathSim)	1) No differences except AS-7:30am: Nap group had fewer lapses (p<.03) and faster reaction time (p<.05) 2) No differences except PI-4am when nap group worsened after nap (p<.05) 3) BS-6:30pm Control group quicker (p<.04), AS-7:30am nap group N.S. quicker (p=0.10)

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
				4) Profile of Mood States 5) Karolinska Sleepiness Scale 6) Driving simulation (StiSim Drive Simulation System) *Measured during nap (3am):* 7) Polysomnographic data	4) AS-7:30am nap group had less fatigue (p<.05) and more vigor (p<.03) 5) AS-7:30am Less sleepiness (p<.03) in nap group 6) Nap group improved dangerous driving and alertness from baseline, control group worsened from baseline (p<.03). No aggregate group differences on intervention day. 7) Average nap time: 24.8 mins (SD=11.1) Average sleep onset: 8.9 mins (SD=5.5)
Yoga and mindfulness interventions					
Babbar (2019) [29] USA Published report	Before-and-after study conducted over 8-week period	N=25 OBGYN trainee doctors and maternal-fetal medicine fellows; M/F ratio not reported	Weekly 1-hr yoga sessions held within protected education time	*Measured before and after 8-week intervention:* 1) Maslach Burnout Inventory 2) Depression Anxiety Stress Scale 3) Five Facet Mindfulness Questionnaire 4) Blood pressure (BP) 5) Heart rate 6) Average weight 7) Feedback survey on program	1) Reduction in depersonalization domain (p=.04). N.S. difference in other 2 domains. 2) Anxiety rates reduced (40% to 28%), stress rates reduced (40% to 24%), no difference in depression. 3) 1/5 domains increased (p=.01). N.S difference in total mindfulness. N.S difference between frequent and infrequent yoga attendees. 4) Systolic and diastolic BP decreased (p=.01). Greater decrease in frequent attendees (p=.04) 5) N.S difference. 6) Increased (p=.03). 7) 74% agreed protected wellness with colleagues improved training experience and felt more appreciated. 83% felt increased sense of camaraderie and more motivated to incorporate wellness in their lives. 90% became more aware of physical activity.
Babbar (2021) [28]* USA Published report *Note: Follow-up to Babbar 2019[23]	Before-and-after study conducted over 8-wk period	N=13 OBGYN trainee doctors and maternal-fetal medicine fellows; M/F ratio not reported	Weekly 1-hr yoga sessions held within protected education time	1) Daily objective sleep data (Polar A370 fitness tracker) 2) Baseline and post-intervention subjective sleep data (Pittsburgh Sleep Quality Index)	1) On yoga days, attendees had greater total (p = 0.04) and restful sleep (p=0.01) than non-attendees. Compared with non-yoga days, attendees had greater total (p=0.05) and restful sleep (p = 0.04) the night following yoga class. 2) N.S changes
Ireland (2017) [30] Australia Published report	RCT conducted over 10-week period	N=44 EM trainees n=23 intervention, n=21 control; 36% M	Wkly 1-hr mindfulness sessions for 10 wks vs 1-hr midday break per wk	*Measured at beginning (week1), middle (week 5), and end (week 10) of intervention:*	1) Intervention group stress decreased over time (p=.007, η^2=0.28). Control group stress N.S increased over time (p=0.302, η^2=0.08).

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
				1) Perceived Stress Scale 2) Copenhagen Burnout Inventory	2) Intervention group burnout N.S improved over time (p=.072, η^2=0.16); Control group burnout N.S. increased over time (p=0.222; η^2=0.10)
Scheid (2020) [31] USA Published report	Before-and-after study (6-wk intervention period)	N=12 faculty physicians; 0% M	Baseline/usual practice vs weekly 1-hr yoga sessions for 6 wks during work hrs	*Measured at baseline, post-intervention and 2 months post-intervention:* 1) Professional fulfilment and burnout (Professional Fulfilment Index); 2) Perceived Stress Scale 3) Resilience Scale; 4) Anxiety, depression and sleep disturbances (Patient-Reported Outcomes Measurement Information System) 5) Positive and Negative Affect Schedule; 6) Five Facet Mindfulness Questionnaire	*Between baseline and post-intervention:* Significant improvements in perceived stress (p=.031), anxiety (p=.045), depression (p=.029), resilience (p=.005), professional fulfilment (p=.031) and burnout (p=.047). N.S change in sleep disturbances, affect and mindfulness. *Between baseline and 2-month follow-up:* Significant improvement in 1 dimension of burnout (p=.038), resilience (p=.024), and mindfulness (p=.012. N.S change in professional fulfilment, overall burnout, perceived stress, anxiety, depression, sleep disturbances and affect.
Microbreak interventions in surgery					
Dorion (2013) [32] Canada Published report	Randomised crossover trial (N=16)	N=16 surgical staff and trainees; M/F ratio not reported	Control vs 20-second micropauses every 20 mins during prolonged (2 hr minimum) surgery	*Rated after control and intervention surgery:* 1) Study-specific rating of physical discomfort; 2) Fatigue (2.5kg weight hold for as long as possible) 3) Star-shaped precision test	1) Micropauses improved discomfort in neck, back, shoulders, wrists, elbows and eyes compared with control (p<.05). N.S difference in legs/lower limbs. 2) Micropauses improved muscular fatigue cf. control (p<.001). 3) Micropauses improved accuracy cf. control (p<0.01).
Engelmann (2011) [33] Germany Published report	Randomised crossover trial	N=7 paediatric surgeons; n=51 operations randomised to intervention (n=26) or control (n=25); 85.7% M	5-min intraoperative breaks every 30 mins (25-min work then 5-min break) vs control (no breaks)	*Measured before, during and/or after surgery:* 1) Salivary cortisol, amylase, testosterone, and DHEA; 2) BP-test of concentration and performance; 3) Fatigue items from NASA Task Load Index; 4) Perceived stress; 5) Pain (neck, arms, spine, knees, eyes); 6) Mean operation time corrected for complexity *Measured continuously:*	Compared with control group, break group showed: 1) Salivary cortisol improvement (p<.05), lower testosterone for female participant (p<.001), N.S difference in amylase and DHEA. 2) Improvement in attention (p<.05) and concentration (p=.06) – error rate 3x lower than control, threshold significance due to outlier. 3) Less post-operative fatigue (p<.005), less intra-operative impairment by fatigue (p<.001)

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
				7) Heart rate and intraoperative ECG events (sudden increase in HR during stressful event)	4) Less intra-operative stress (p<.05) 5) Less musculoskeletal strain (all p<.001 except eyes, p=.09) 6) No difference in mean operation time (breaks did not prolong operations, p>.05) 7) Fewer intraoperative events (p<.05), less increase in heart rate (p<.05)
Engelmann (2012) [34]* Germany Published report *Note: Follow-up to Engelmann 2011[33]. Includes patients as participants	RCT	N=7 paediatric surgeons and N=52 paediatric patients; surgeons 85.7% M	Patient outcomes and surgeon perceptions of 5-min intraoperative breaks every 30 mins (25-min work then 5-min break) vs control (no breaks)	*Patient outcomes measured during surgeries:* 1) Cardiovasular monitoring; 2) Urine volume; 3) Blood gas parameters; 4) Body temperature *Surgeon feedback measured 1 month after intervention:* 5) Team communication; 6) Team coordination; 7) Were there any welcome breaks vs any particularly unwelcome breaks?; 8) Overall scheme ratings; 9) Individual work style (fast, slow, exact, standardized, creative, alternating)	1-4) No difference between control and intervention groups in any patient outcomes. *Surgeon feedback:* 5) With breaks team communication changed from implicit (little verbal feedback) to explicit (outspoken) (p<.05) 6) More coordination required for break scheme but not significant (p>.05) 7) Unwelcome breaks scored N.S higher 8) Overall approval rating: 5.9/10 (+/- 3.2) 9) Slow operators more in favour of break scheme than fast operators (p<.05)
Hallbeck (2017) [35] USA Published report	Before-and-after study. 1 control day followed by 1 intervention day. Approx. 1 wk between control and intervention.	N=56 Consultant surgeons; 67.9% M	Control surgery day with no breaks vs one day of 1.5-2 min intraoperative microbreaks with guided exercises every 20-40 mins	*Measured pre- and post-surgery (control and intervention days):* 1) Surg-TLX and GOAL questionnaire; 2) Musculoskeletal pain (Adapted Nordic Musculoskeletal Questionnaire) *Measured after intervention:* 3) Physical performance; 4) Mental focus; 5) Distractions and workflow interruptions caused by breaks; 6) Desire to incorporate into routine	1) N.S difference in surgery duration, degree of difficulty, complexity, distractions, and mental and physical demands between intervention and control surgeries 2) Improvement in right and left shoulder pain (p<.001) with microbreaks compared with control 3) Improved by breaks: 62%; No change: 46% 4) Improved by breaks: 34%; No change: 53%; Reduced: 12% 5) Distractions: 2/10, Workflow interruptions: 2/10 6) 87% answered yes

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Microbreak interventions - other					
Lemaire (2010) [36] Canada Published report	Before-and-after study. 2-day protocol	N=20 medical, surgical, and primary care staff physicians; n=17 day shifts, n=3 night shifts; 85% M	Standard/usual practice day vs one day of micro-food-breaks (delivery of 6 small daily meals) Baseline day preceded intervention day, both days occurred within 2 wk period	*Measured at baseline (7:30am) and 2-hourly intervals until end of day:* 1) Simple reaction time and complex reaction time (Brain Checkers software); 2) Capillary blood glucose samples (Precision Xtra Blood Glucose); 3) Volume of fluid consumed and urine voided; 4) Diet recall/food diaries; 5) Checklist of 17 hypoglycemic nutrition-related symptoms	1) Intervention improved speed and accuracy on simple reaction time test (p=0.01) and complex reaction time test (p<.001) 2) Blood glucose levels reduced on intervention day (p=0.03) and less variable 3) Fluid intake (p=.04) and urine output (p=.008) improved by intervention 4) Intervention increased caloric intake (p=.008) 5) N.S reduction in hypoglycemic nutrition-related symptoms on intervention day (p=0.36). 70% ppts reported fewer symptoms or no change compared with baseline
Mengin (2021) [37] France Published report	Randomised control trial	N=47 ENT trainee doctors; 47.7% M	Effect of listening to a 5-min guided mindfulness meditation vs control track prior to a simulated consultation where doctors break bad news to patients	Measured post-simulation only 1) Performance (rated by blinded expert assessors on bad-news consultation scale); 2) Physician self-rated empathy (visual analogue scale); 3) Patient perception of physician empathy (Jefferson Scale of Patient Perceptions of Physician Empathy) Measured pre-intervention, post-intervention and post-simulation 4) Self-rated stress (visual analogue scale); 5) Doctor self-rated confidence (visual analogue scale)	1) Performance improved in mindfulness group compared with control group (p=.026). Fewer participants rated as "fail" by assessors in the mindfulness group than control (4.3% vs 30.4%, p =.04) 2) N.S difference in self-rated empathy 3) N.S difference in patients' perceived empathy across groups. Perceived empathy positively correlated with performance (r=0.541, p<.001). 4) N.S difference in perceived stress 5) N.S difference in doctor confidence
Survey and cohort studies					
Al Dandan (2020) [38] Saudi Arabia Published report	Cross-sectional survey	N=198 clinical radiology trainees, and consultants; 56.1% M	Break-taking prevalence as a predictor of digital eye strain	1) Symptoms of digital eye strain 2) Break frequency (% of participants) 3) Break duration (% of participants)	1) Infrequent break-taking (once or twice per day) was a predictor of digital eye strain compared with more frequent break-taking 2) 25.3% once/day, 30.8% twice/day, 32.3% every 2 hours, 11.6% at least hourly 3) 10.6% <5 mins, 45.0% 5-10 mins, 28.3% 11-15 mins, 16.1% >15 mins

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Winston (2008) [39] England, UK Published report	Cross-sectional survey	N=328 hospital doctors of varying grades; M/F ratio not reported	Break prevalence and healthy eating behaviours	1) Study-specific checklist of potential barriers to healthy eating 2) Break prevalence	1) Lack of breaks rated the most common barrier to healthy eating (66%). Next most common barriers: Lack of food choices (56%) and canteen opening times (48%). 2) Prevalence of regular break taking: 46%
Hassan (2020) [40] Egypt Published report	Cross-sectional survey	N=278 surgical and medical trainee doctors; 46.4% M	Association between break prevalence and level of work stress	Adapted version of the Hospital Consultants' Job Stress and Satisfaction Questionnaire (work characteristics rated for their contribution to work-related stress). Stress scores categorized as low, moderate and high.	High stress scores associated with lack of breaks during working hours (76.9% of low/moderate stress group not taking breaks vs 93.3% of high stress group not taking breaks, p=.001) Barriers to break taking: 50.7% of participants described rest areas as limited, 38.8% as sufficient for one person only, 1.8% as big enough, 8.7% reported no rest areas
Kirkcaldy (2002) [41] Germany Published report	Cross-sectional survey	N=309 doctors and consultants who own a medical practice; 63.4% M	Association between break duration and occupational stress, motor vehicle accident rates, and work-related accident rates	1) Study-specific questionnaire about occupational stress 2) Number of motor vehicle accidents 3) work-related accidents during previous 12 months 4) Break duration: Lunch break start and end time reported	1a) Occupational stress showed a significant negative association with lunch break duration (r=-0.19, p<.05) 1b) In predictor model of job stress break duration was significant (β=-0.16, p=.03) alongside 3 factors: weekly working hours, no. of dependent children and work satisfaction (R^2 adj = 0.12, p<.001) 2) Break duration not significant predictor of motor vehicle accident rates 3) In predictor model of work-related accidents, shorter lunch breaks were included (β=+.0.10, p<.10) alongside 1 factor: high levels of job commitment 4) Working longer hours significantly associated with shorter lunch breaks (p<.001)
Nitzsche (2017)[42] Germany Published report	Cross-sectional survey	N=152 private practice haematology and oncology physicians; 73% M	Association between breaks, emotional exhaustion and work-home conflict	1) Maslach Burnout Inventory (emotional exhaustion scale) 2) Work home conflict: Effect of work on private life (Survey Work-Home Interaction – NijmeGen)	1) Significant indirect effect of breaks on emotional exhaustion, mediated by work-home conflict (p<.05, β = -0.22). No direct effect. 2) Breaks directly related to work-home conflict. WHC reduced by breaks (β=-.33, p<.05).

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
				3) Home-work conflict: Effect of private life on work 4) Two study specific questions about how often breaks are taken	3) No direct effect of breaks on home-work conflict. 4) 1/4 took regular breaks, 16% never took breaks.
Kalboussi (2020) [43] Tunisia Published report	Cross-sectional survey	N=46 anaesthetists of varying grades; 11% M	Association between taking breaks at work (among other occupational factors) and burnout	1) Maslach Burnout Inventory 2) Breaks at work dichotomised into "Yes" or "No"	N.S association between burnout and break-taking (p=0.790)
Ohlander (2015) [44] Sweden & Germany Published report	Cross-sectional survey Data from the 2nd of 3 follow-up surveys in cohort study.	Swedish sample: N=85 physicians; 60% M. German sample: N=561 physicians; 48.5% M	Association between break duration and work stress in two different countries	1) Work stress (Effort-Reward Imbalance questionnaire) 2) Minutes of break per day	1a) Sweden: Negative association between work stress and break duration (β=-0.002, p=.03) 1b) Germany: N.S. association, break duration not included in regression model 2) German sample had shorter breaks per day than Swedish sample (28.2 +/- 18.1 min/day vs 40.4 +/- 20.9 min/day)
Berastegui (2020) [45] Belgium Published report	Observational prospective longitudinal study conducted over 10-month period	N=28 ED doctors; 60.7% M	Association between fatigue reduction strategies with a) reaction time, and b) burnout. Fatigue reduction strategies: Used to reduce subjective on-the-job fatigue e.g. rest, nap, have a snack, get fresh air, listen to music, etc.	*Measured at baseline only:* 1) Checklist of fatigue reduction strategies (FRS, checklist based on previous focus group data) 2) Maslach Burnout Inventory measured at baseline only *Measured during each shift (6:30-7:30pm for day shift, 9:30-11pm for night shift):* 3) Psychomotor Vigilance Task (PVT)	1) Higher FRS use significantly associated with faster reaction times on PVT (p=0.01) 2) FRS use not significantly associated with burnout
Hockey (2020) [46] England, UK Published report	Observational prospective longitudinal study	N=565 trainee doctors; 42% M	Association between breaks and positive and negative affect	*Tasks and affect measured during 2-hour windows. Repeated 5 times in different shifts.* Intensity of positive affect (competence, enjoyment, friendliness, happiness) and negative affect (worry, tiredness, impatience, hassle, frustration, criticism) when reporting a break	Compared to shifts with breaks, in shifts without breaks participants experienced significantly greater feelings of negative affect and significantly less feelings of positive affect on all measured domains.

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Neprash (2018) [47] USA Conference presentation* *Report published did not include break data.	Retrospective cohort study (Secondary analysis of electronic records spanning 2013-2014 period)	N=2,805 primary care doctors (n=703,612 appointments); M/F ratio not reported	Opioid, NSAID and physical therapy prescribing rates immediately before and after breaks of >15 mins (during appointments where opioids were likely inappropriate)	1) Opioid, NSAID and physical therapy prescribing rates for outpatient appointments (per electronic health record systems) 2) Breaks: Gap of >15 mins in schedule	Doctors 4.9% more likely to inappropriately prescribe opioids before breaks than after (p=0.02) N.S. relationship with physical therapy orders and NSAID prescribing
Vosshenrich (2021)[48] Switzerland Published report	Retrospective cohort study (secondary data analysis of trainee doctors' reports)	*N*=117,402 reports written by *n*=27 trainee doctors; M/F ratio not reported	Effect of lunch breaks on number of corrections made to trainee doctor's reports in proofreading process	Similarity (%) of preliminary reports to final corrected versions (Jaccard similarity coefficient)	Report similarity temporarily increased after breaks (lunchtime), suggesting recovery. However, recovery effect reduced as the week progressed and disappeared towards end of the week.
QUALITATIVE STUDIES					
Qualitative appraisals of interventions					
Lemaire (2011) [49]* Canada Published report *Note: qualitative follow-up to Lemaire 2010 quantitative intervention study[36]	Before-and-after study evaluation using semi-structured interviews	N=20 medical, surgical, and primary care physicians; 85% M	Standard/usual practice day vs one day of micro-food-breaks (delivery of 6 small daily meals) Baseline day preceded intervention day, both days occurred within a 2-week period	Semi-structured interviews before and after intervention (15-45 min duration) analysed inductively by 2 coders	Impact of inadequate nutrition: 1) Emotional symptoms (e.g. irritability); 2) Physical symptoms (e.g. inability to focus or concentrate); 3) Affects ability to work (efficiency, focus); 4) Affects interactions with others (colleagues and patients). Barriers to adequate nutrition: 1) Lack of time due to workload and schedule; 2) Lack of access to nutrition (distance of facilities, queues, opening hours); 3) Lack of food choices; 4) Work ethic (work/patients come first); 5) Professionalism (unprofessional to eat in patient areas). Impact of participating in the intervention: 1) Increased awareness of workplace nutrition and impact; 2) Intention to change future habits and eat more regularly.

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
Lockhart (2013) [50] Canada Conference abstract	One-group post-test only design using qualitative survey evaluation	N=5 rheumatology senior trainees; M/F ratio not reported	1-hour circuit-training-style exercise session for 12-week period instead of lecture as part of academic half-day	Qualitative survey administered in week 9 of 12	1) Program resulted in changes to diet, stress, sleep habits, mood, learning and time-off activities; 2) Participants perceived program as effective use of time and resources, preferable over teachings; 3) 4/5 participants desired focused instruction on beneficial exercises for patients; 4) 3/5 confidence in exercise prescribing increased; 5) 5/5 participants perceived work and training as barrier to exercise; 6) 3/5 had not previously participated in regular exercise. 2/5 participated twice wkly. Post-intervention 4/5 complete 1-3 sessions of exercise >30 mins.
Other qualitative studies					
Hall (2018) [51] England, UK Published report	Single occasion focus groups	N=25 General practitioners (locums, salaried, trainees, and partners); n=5 focus groups; 44% M	Breaks as potential strategy to improve general practitioner wellbeing	Inductive thematic analysis (2 coders)	Breaks: 1) Scheduled short breaks as feasible strategy to improve wellbeing. Lunch breaks not deemed realistic but short coffee breaks feasible; 2) Breaks as opportunity to leave the work space, interact with colleagues, and/or have respite from work; 3) Breaks valued where they are common practice and desired where they are not; 4) Increase in resources perceived as fundamental to enabling time for breaks
Morrow (2014) [52] UK (England, Scotland Wales, Northern Ireland) Published report	Focus groups and telephone interviews	N=82 medical, surgical and psychiatry trainee doctors; 44% M	Effect of UK Working Time Regulations (WTR) on trainees' experience of fatigue (including effect on breaks and rest periods)	n=11 focus groups (60-90 mins) and n=30 telephone interviews (30-45 mins) for participants who could not attend focus groups Analysed using a framework approach (2 coders)	WTR implementation in practice: 1) Fatigue still experienced despite regulations (e.g. due to work compression and intensity); 2) Rest facilities being reduced and less capacity to take breaks or rest; 3) Lost rest periods due to senior staff lack of awareness of them. Effects of fatigue: 1) Detriment to skills, judgement, efficiency, mood, ability to retain new information; 2) Effects compounded by hunger/discomfort from inability to take breaks
O'Shea (2020) [53] USA Published report	Focus groups	*N*=116 EM doctors (all grades); M/F ratio not reported	Beliefs about taking breaks for self-care while on shift	*n*=8 one-hour focus groups conducted separately with trainees and consultant doctors. Analysed for	Six themes: 1) ED Doctors have innate physiological needs which affect cognitive function and emotional regulation; 2) Shared beliefs (culture) on break-

First author (year), Country, Publication Type	Design	Population	Break type and/or topic of investigation	Break-related outcome measurement(s)	Break-related result(s)
				themes by 3 coders and validated by participants.	taking relate to productivity and patient safety as a strength, and self-care as a weakness; 3) Breaks can create delays and negatively impact patient safety, though no participants had experienced this personally; 4) The ability to take breaks requires certain skills, safety-oriented communication strategies, and practice; 5) Changing the cultural norms would require approval from peers and other staff; 6) Breaks need to be flexible in form and duration and cater to individual needs and circumstances.
Walsh (2005) [54] Canada Published report	Semi-structured individual interviews	N=21 female family medicine trainee doctors; 0% M	Effect of access to breaks on ability to breastfeed when returning to work from maternity leave	Semi-structured individual interviews analysed for themes	1) Breastfeeding valued but often unable to continue at work. 2) Maintaining breastfeeding contingent on ability to take breaks to express breast milk. Additional requirements: privacy, good breast pump, refrigerated storage and sympathetic seniors.
MIXED METHOD STUDIES					
Wilkesmann (2016)[55] Germany Published report	Sequential mixed method design	N=43 qualitative semi-structured interviews with hospital physicians; N=2,598 quantitative surveys from surgeons and anaesthetists (trainee doctors excluded); M/F ratio not reported	Impact of breaks on opportunities for physicians to 'share ignorance' (detect unknown things and share them, ability to learn from failures) or 'hide ignorance' (intentionally prevent knowledge sharing) Ignorance: a known or unknown lack of knowledge	1) Qualitative semi-structured interviews analysed using content analysis firstly deductively then inductively to form hypotheses for subsequent testing in the quantitative survey 2) Quantitative survey item: Effect of breaks ("I usually take opportunities to discuss work related things in my work break with colleagues") on a) hiding ignorance and b) sharing ignorance	1) <u>Qualitative findings:</u> Breaks could serve as informal, face-to-face opportunity to share ignorance and learn from it 2) <u>Quantitative findings:</u> a) Breaks had N.S. effect on hiding ignorance (p=0.64) b) Breaks had a significant effect on sharing ignorance (p<.001)

Legend and Abbreviations: 'Trainees' – includes any/all grades unless specifically stated. Consultants – fully trained in specialty, includes 'attending physicians/ surgeons'. EM – Emergency Medicine specialty. ED – Emergency department. OBGYN – Obstetrics and Gynaecology. ENT- Ear, Nose and Throat. NSAIDS – non-steroidal anti-inflammatory medication. WTR – working time regulations. UK- United Kingdom. RCT- Randomised control trial

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	P1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	P2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	P3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	P3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	P4-5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Supp p2-6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supp p2-6
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	P5-6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	P5-6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	n/a
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	n/a
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	P6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	n/a
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	n/a
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	n/a
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	n/a
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	n/a
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	n/a
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	n/a
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	n/a
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	n/a

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Fig 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	n/a
Study characteristics	17	Cite each included study and present its characteristics.	Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Table 2-6
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	n/a
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	n/a
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	n/a
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	n/a
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	n/a
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	n/a
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	n/a
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pp18-19
	23b	Discuss any limitations of the evidence included in the review.	P18
	23c	Discuss any limitations of the review processes used.	P18
	23d	Discuss implications of the results for practice, policy, and future research.	P19
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	P2
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	P2
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	n/a
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	P20
Competing interests	26	Declare any competing interests of review authors.	P20
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	n/a

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

PRISMA 2020 Checklist

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