



Public Health
Research Consortium

Project Final Report

The health and wellbeing effects of changing the organisation of shift work: a systematic review

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The work was undertaken by the Centre for Public Policy and Health (University of Durham), the MRC Public and Social Health Sciences Unit (Glasgow), the Centre for Reviews and Dissemination (University of York), and the Department of Public Health at the University of Liverpool as part of the work of the Public Health Research Consortium (PHRC). The Public Health Research Consortium is funded by the Department of Health Policy Research Programme. The views expressed in the publication are those of the authors and not those of the DH. Information about the wider programme of the PHRC is available from www.york.ac.uk/phrc.

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PREFACE

What this study adds

Work is an important social determinant of health. There is extensive research which describes the negative effects of shift work on health and wellbeing. Shift work may therefore be a common, but largely overlooked, determinant of health and wellbeing for many workers. A range of potential organisational interventions (such as the ergonomic redesign of shift work schedules) has been suggested to address the negative health effects of shift work. The effects of some of these interventions have been evaluated in primary studies. However, this study is the first systematic literature review of the health and wellbeing effects of changing the organisation of shift work.

The review has found that interventions which alter the organisation of shift work are seldom health-damaging and can often have positive effects on wellbeing. Four types of intervention in particular have been found to be beneficial: Compressed Work Week (CWW), slow to fast rotation, backward to forward rotation, and self-scheduling. Although there are some reservations about the extent and quality of the evidence base on shift work reorganisation, overall, this systematic review suggests that organisational level workplace interventions can improve the health and wellbeing of shift workers. The workplace is therefore rightly considered by UK policymakers to be an important arena for improving health and wellbeing: the evaluation of the health impacts of new interventions (such as new policies, or new regulations) in this setting should be a priority if the health of the public is to be protected and improved in the future.

EXECUTIVE SUMMARY

Background

Recent reports from the UK Department of Health and Department of Work and Pensions, the US Department of Health and Human Services, and the World Health Organization show that the workplace is increasingly being recognised by policymakers as an important intervention point at which health can be improved and health inequalities reduced. There is a largely-untapped literature on the effects of particular types of work patterning on health and health inequalities, and in particular there is a large body of evidence spanning several decades, which describes the (often negative) effects of shift work on health and wellbeing. Shift work may therefore be an important, but largely overlooked determinant of health and wellbeing for many workers. Changes to the organisation of shift work therefore have the potential to reduce negative health effects and perhaps also impact upon social inequalities in health and wellbeing.

Aims

To systematically review primary empirical studies in any language on the health, wellbeing and economic impacts of changes to the organisation and experience of shift work, and to identify any differential impacts by socio-economic or demographic group.

Design and methods

Systematic review of interventions that change the organisation of shift work. Following QUORUM guidelines we sought published or unpublished experimental and quasi-experimental studies (in any language) that evaluated the health, wellbeing and economic effects of such interventions in electronic databases, websites and bibliographies. Studies were critically appraised and assessed for methodological quality by two reviewers and the best available evidence was synthesised narratively.

Main findings

66 studies were located. These related to two types of organisational change: Compressed Work Week (CWW) and schedule redesign. The review is cautiously positive about the health effects of CWW interventions, suggesting that whilst they might not always improve the health of shift workers, they are seldom detrimental. Similarly, the CWW interventions have few reported positive or negative economic effects. However, the evidence about the effects of CWW interventions on the wellbeing of shift workers is more conclusive: CWW may improve wellbeing especially in terms of work/life balance, though the potential for publication bias in the evidence base is noted. The schedule redesign interventions were less homogeneous and the effects were somewhat mixed: interventions which changed the rotation of shift work tended to either improve health and wellbeing, or leave them unaltered. The economic effects were more mixed. Similarly most of the other schedule redesign interventions (such as changes to night work) produced mixed and inconclusive results. However, changes from backward to forward or slow to fast rotation, and self-scheduling amongst shift workers were

reported to have positive health, wellbeing and economic effects. Generally, health and wellbeing may be more likely to be improved by interventions which involved workers in their design and implementation.

Considerations/issues for policy

Changing the organisation of work can have positive health and wellbeing effects: The review suggests that certain interventions (particularly CWW, slow to fast rotation, backward to forward rotation, or self-scheduling) which change the organisation of shift work, can be beneficial to the health and wellbeing of workers. Future guidance to employers about the effects of changing the organisation of shift work could reflect these positive effects. Importantly, these types of intervention tend to have either positive or negligible economic effects and so health and wellbeing can potentially be improved through the workplace without damaging productivity or competitiveness if adverse effects (such as increases in fatigue or risk) are identified and mitigated. This message can be a useful aid in implementing the recent cross-departmental 'Health, Work and Wellbeing' strategy amongst employers: Changing shift work organisation and working practices to make them 'healthier' or more conducive to a work/life balance does not necessarily carry an economic warning.

1. BACKGROUND

Work has long been acknowledged as an important social determinant of health and health inequalities. [1-4] Employment, or lack of it, and the quality and type of employment are vital in terms of income and social status in all advanced industrialised societies. Work also dominates adult life. [5] However, the nature of work has altered considerably in the UK and other developed countries over the past two decades, not least because there has been a significant decrease in levels of physical work based in industrial and manufacturing employment, and an increase in the size of the service sector. The labour market has also seen considerable changes with increases in part-time work, more participation by women, and the emergence of structural unemployment and job insecurity.[6] This has also been accompanied by the cultivation of labour market practices in which skills, working hours, contracts, conditions, pay and location are more flexible. Similarly, a 24 hour society has started to emerge with associated concerns about abnormal working hours.[7]

In this context, it is perhaps unsurprising that recent reports from the UK Department of Health and Department of Work and Pensions, the US Department of Health and Human Services, and the World Health Organization show that the workplace is increasingly being considered by policymakers as an important intervention point at which health can be improved and health inequalities reduced.[4, 8-11] Attention to date though has focussed exclusively on the psychosocial work environment, as explored in depth in the Whitehall studies.[12-16] However there is a considerable

literature on the effects of particular types of work patterning on health and health inequalities, and in particular there is a large body of evidence spanning several decades, which describes the negative effects of shift work on health and wellbeing.[17, 18]

Reported health problems include sleep disturbances, fatigue, digestive problems, emotional problems and stress-related illnesses, as well as increases in general morbidity, and in sickness absence.[19] These problems may derive from disruption to physiological, psychological and social circadian rhythms.[17, 18] Shift work, particularly that involving night work, disrupts the natural circadian rhythm as it requires people to be active at times when they would normally be sleeping and vice versa. [18] This leads to sleep problems (as natural alerting mechanisms such as the cortisol surge and temperature rise will interrupt sleep) as well as daytime functioning (wakefulness at night will be reduced by temperature drops and melatonin surges). Sudden changes in schedule can therefore have an effect akin to 'jet lag'. Disruption to the circadian rhythm can also lead to disharmony within the body as some functions (e.g., heart rate) adapt more quickly than others (typically endogenous functions such as body temperature, melatonin). This leads to desynchronisation which itself can result in psychological malaise, fatigue and gastro-intestinal problems. Realignment can take several weeks.[18] Most existing research emphasises the physiological changes which shift work induces, but shift work also involves significant *social* desynchronisation, involving working at times and on days that may make it difficult to maintain a balanced domestic and social life.[20]

Previous studies suggest that cardiovascular problems such as hypertension and heart disease may be related to the physiological and psychological aspects of long term exposure to shift work.[21-23] A study of the epidemiological literature funded by the Health and Safety Executive, the Medical Research Council and the Department of Health [22, 23] found that whilst a causal relationship between shift work and breast cancer is biologically plausible, the empirical evidence base is not sufficient to confirm or refute it. Shift work may also involve increased risk of injuries and accidents as performance fluctuates.[24, 25] For example, the Health and Safety Executive reports that the incidence of accidents and injuries is higher on night shifts, after a succession of shifts, when shifts are long or when there are inadequate breaks. [25]

Shift work may therefore be an important, but largely overlooked determinant of health and wellbeing for many workers. It is common in the UK, and is increasing;[22, 25] according to the Health and Safety Executive 3.5 million people are employed in shift work,[25] though the definition of the term can be complex (the Labour Force Survey for example identifies ten different categories).[26] Shift work is also socially patterned, being less common in graduates, and more common among those working in the manufacturing or health care sectors.[26]

Changes to the organisation of shift work have the potential to reduce these negative health effects and perhaps also impact upon social inequalities in health and wellbeing. A range of interventions has been suggested to address the negative effects of shift work. These include at the individual level: exposure to bright light or napping; training, counselling and education; countermeasures against sleep problems, problems with appetite and digestion; educational interventions (e.g., to help workers to cope with shift work); regular medical surveillance and pharmaceutical interventions (e.g. melatonin administration); and selection strategies to remove the most vulnerable.[18, 27] At the organisational level interventions include: changes to the hours of shift work (especially night shift); redesign of shift work schedules (according to ergonomic criteria or to increase flexibility); improvements in working conditions (reducing noise or improving unfavourable working environments); and legislation limiting working hours or exposure to shift work (e.g. the EU Working Time Directive, and its subsequent revisions).[24]

The effects of some of these interventions on health and wellbeing have been evaluated in primary studies. In this report, we present the results of a systematic review of primary empirical studies on the health and wellbeing impacts of organisational level changes to shift work and any differential impacts by social group. Although previous literature reviews exist in the area of shift work and health, these often concentrate on epidemiological (descriptive or comparative) rather than evaluative intervention studies, tend to cover individual-level interventions only, do not specifically examine

intervention studies, focus on certain occupational groups only, or have not been conducted using systematic review methodology. [7, 19, 28-32] it should also be noted that this is a research review, rather than a guide to implementation and so it focuses primarily on the findings of studies which have explicitly evaluated the health (and related) effects of interventions, rather than the wider shiftwork literature.

2. PURPOSE OF THE STUDY

The purpose of this study was to systematically review primary empirical studies in any language on the health and wellbeing impacts of changes to the organisation and experience of shift work and to identify any differential impacts by socio-economic or demographic group. Sub-questions for the review concerned the effects of specific interventions.

3. DESIGN AND METHODS

3.1 Inclusion and Exclusion

We sought to identify all empirical studies (both prospective and retrospective, with or without control groups) that examined the effects of organisational level interventions on the health and wellbeing of shift workers and their families. For the purposes of the review, shift work was defined as “any regularly taken employment outside the hours of 0700 and 1800”. [18] Interventions had to be implemented in actual workplaces and so non-workplace laboratory based studies were excluded. A range of health-related outcomes were considered relevant including changes in the prevalence of specific diseases (such as musculoskeletal disease or circulatory disease) as

well as more general or indirect measures of physical or psychological health and wellbeing (such as GP visits or the General Health Questionnaire). Sickness absence, health behaviours (cigarette or alcohol consumption, physical activity) and injuries resulting from accidents were also included. Physiological measures, such as hormone excretion levels or body temperature, were also included as were measures of physical and mental wellbeing such as tiredness, fatigue and sleep (although it is not always clear as to what they represent in actual health terms).[22] Wellbeing was also conceptualised in terms of the social impacts of the interventions, specifically on work/life balance (such as quality of life, or time spent with family) and the psychosocial work environment (such as levels of job demand, control or support). Economic effects including individual and organisational performance measures (such as productivity, or levels of job satisfaction) were also - where reported alongside the primary outcomes (health and wellbeing) - recorded to help in understanding the motivations behind the organisational interventions and also their viability. Impacts on inequalities in health or wellbeing were also considered as outcomes.

3.2 Search Strategy

We searched 27 electronic databases from date of inception to November 2005, as well as bibliographies, reference lists, and websites for documents of any type, from any country, at any time and in any language, including conference proceedings, unpublished manuscripts, theses and government-commissioned reports. We also searched existing databases that were assembled for previous systematic reviews on work and health (see

http://www.msoc-mrc.gla.ac.uk/Evidence/Research/Research_MAIN.html).

We developed a search strategy that prioritised sensitivity, varying terminology to allow for the levels of sophistication of the specific databases examined. (full search strategy presented in Appendix 1).

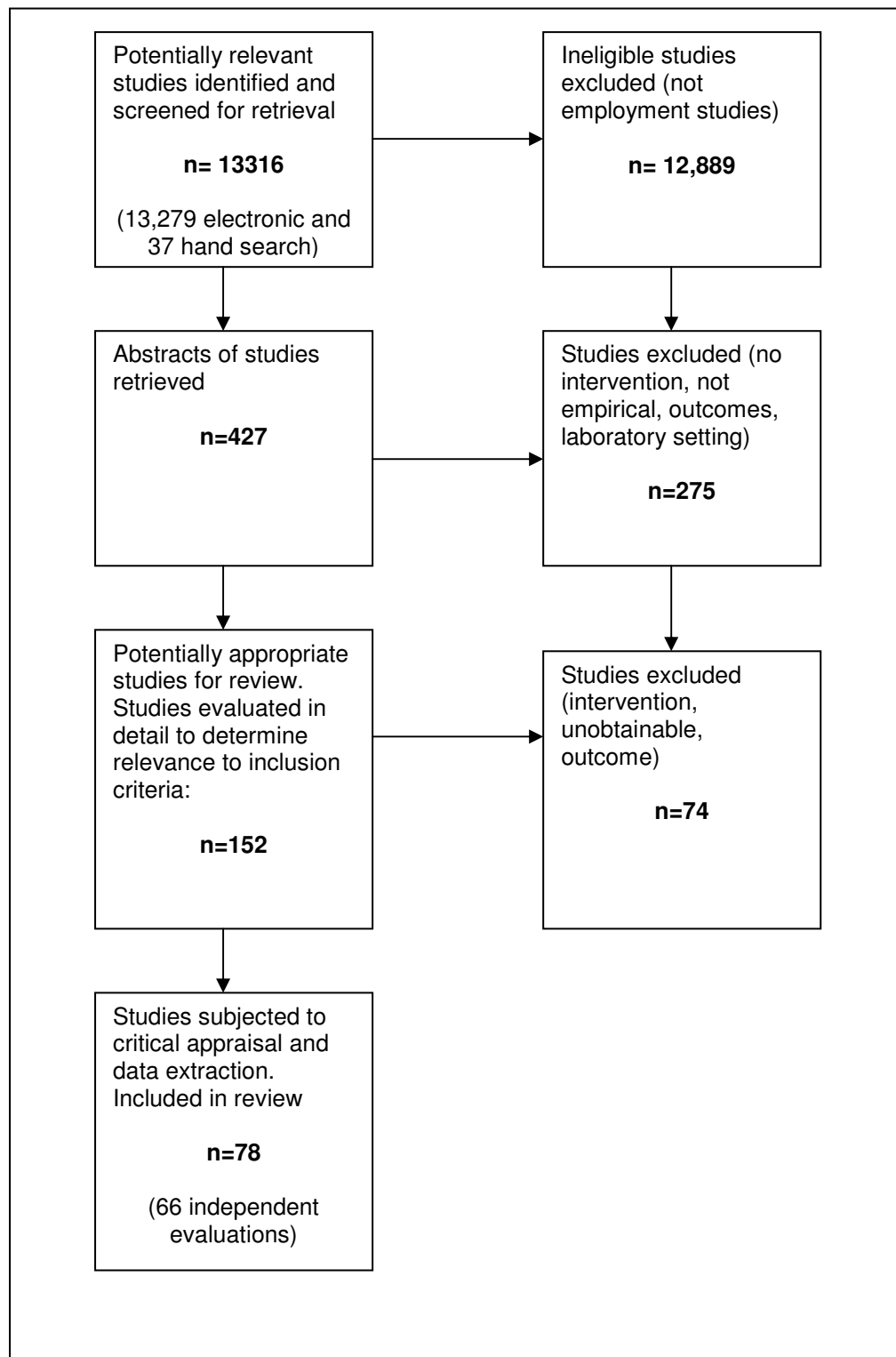
3.3 Data Extraction and Critical Appraisal

We initially located 13316 titles and abstracts, of which 152 were retrieved for detailed examination analysis (see Figure 1). Five of the 152 were non-English language publications. Critical appraisal criteria were adapted from existing systematic reviews of the health effects of social interventions and, guidance for the evaluation of non-randomised studies (Box 1).[33-35] Following the Centre for Reviews and Dissemination's systematic review guidance, two reviewers independently appraised the included studies according to these criteria (see Appendix 2).[36] Data extraction (see Appendix 3) was carried out by one reviewer (CB) and checked by a second (MP). Data on type of intervention, setting, population characteristics, sample size, length of follow-up, implementation, and outcome measures used were extracted when available (this information is presented in the summary results tables 1-7, Appendix 3). Percentages, confidence intervals (CIs), p values, and effect ranges were extracted from the studies or calculated if sufficient information was available. When reviewers' conclusions over the validity of a study differed, the study was reviewed jointly. Data heterogeneity meant that meta-analysis of the results was not possible and so narrative synthesis was performed.

Box 1: Critical appraisal criteria

1. Is the study prospective?
2. Is there a representative sample?
3. Is there an appropriate control group?
4. Is the baseline response greater than 60%?
5. Is the follow-up greater than 80% in a cohort study, or greater than 60% in a cross-sectional study?
6. Have the authors adjusted for non-response and drop-out?
7. Are the authors' conclusions substantiated by the data presented?
8. Is there adjustment for confounders?
9. Were the entire intervention group exposed to the intervention?
Was there any contamination between the intervention and control groups?
10. Were appropriate statistical tests used?

Figure 1: Search flow



4. MAIN FINDINGS

A total of 66 studies reported in 78 publications were included. All of the studies were set in Western Europe, the USA, Canada, Japan or Australia. These were all English language publications. The studies were based in one of five distinct occupational settings: health care organisations (13), emergency services (15), manufacturing companies (23), transport (3) and energy industries (9). The majority of studies were of male manual workers. The earliest study dated from 1933.[37] Fifty-three of the 66 studies were located from electronic databases and the other thirteen were identified from citation follow-ups. Forty of the 53 studies identified from electronic databases were located in either Medline (27) or Embase (13). Fifty-five studies were journal papers, whilst eleven were book chapters, theses or other grey literature reports. In terms of study design, only one trial was found (a cross over trial). However, 57 cohort studies were included, 43 of which were prospective and 17 of which also had a control group (workers from a different department in the same workplace or from a similar worksite). In addition, eight cross-sectional studies were included, five of which were prospective, three of which had a control group. The studies measured a wide range of health and wellbeing outcomes (Box 2).

Box 2: Range of outcomes measured in the reviewed studies

Health related outcomes

General health; Feeling unwell; Physical health; Headaches; Stomach aches; Physiological distress; Gastro-intestinal complaints; Heart problems; Circadian malaise; Cardiovascular health; Muscular complaints; Minor infections; Dimmed sight; Sore throat; Appetite disturbances; Neurovegetative complaints; Cholesterol levels; BMI; Weight; Blood pressure; Sleep (quality and duration); Tiredness; Fatigue; Napping ; General Health Questionnaire; Stress; Anxiety; Anger-frustration; Depression; Irritability; Mental health; Somatic Anxiety; Sport/Exercise; Consumption of social drugs; Eating habits; Alcohol consumption; Caffeine consumption; Cigarette consumption; Sickness absence; Accidents and injuries; Visit to doctors.

Social wellbeing outcomes

Work life balance

Work interference with social/domestic life; Time spent on domestic chores; Family satisfaction; Personal life disrupted; Planning social life difficult; Domestic arrangements difficult; Poor relations with family; Not enough free time; Adjust personal routine for work; Missed social events; Satisfaction with leisure time; Life satisfaction; Conflict between work and non-work time; Social/community involvement; Planning activities with family; Childcare; Time spent on hobbies; Time spent on family matters; Time spent with spouse; Time spent socialising with friends.

Work environment

Tensions due to job; Tensions due to people; Tensions due to job characteristics; Satisfaction with hours; Workload; Work pace control; Managerial control; Staff innovation; Staff autonomy; Role clarity; Opportunity to use skills; Opportunity to make decisions; Relations with co-workers and supervisors; Work pressure; Peer cohesion; Job involvement; Supervisor support; Autonomy; Task orientation; Control; Innovation.

Economic outcomes

Job satisfaction; Effective at work ;Fatigue affects work; Turnover; Incidents and errors; Alertness; Effectiveness; Personal productivity; Organisational effectiveness; Performance; Production quality; Staffing costs; Errors.

The studies were categorised into two broad types of shift work reorganisation (Box 3): the introduction of the Compressed Work Week (CWW)[38], and the redesign of shift work schedules.

Box 3: Key terms relating to organisation of shift work

Compressed Work Week (CWW)

The CWW is an alternative work schedule in which the hours worked per day are increased whilst the days worked are decreased in order to work the standard number of weekly hours in less than five days.³⁸ The most popular forms are the *12 hour CWW*, *10 hour CWW* and the *Ottawa* system. The *12 hour CWW* involves four 12 hour shifts (day, night) over four days with three or four days off. Under a *10 hour CWW*, four 10 hour shifts are worked followed by three days off. The *Ottawa* system consists of three or four 10 hour morning or afternoon shifts spread over four days then two days off. This is followed by a block of seven 8 hour nights then six days off.

Rotation

Rotating shift systems mean that each worker will work all the types of shift e.g. on a 3 shift system they would work morning, afternoon and night shifts at some point in the schedule, on a 2 shift they would work days and nights. *Permanent* or *fixed* (non-rotating) shift schedules are those in which each employee will work only one type of shift on a regular basis e.g. the morning shift or the night shift.

Fast rotation occurs when different shifts are worked within a week. For example, two consecutive morning shifts followed by two night shifts, followed by three rest days. In *Slow rotation*, shifts change weekly or less often.²⁹ For example, a week of mornings followed by a week of afternoons. Generally *fast rotation* enables more frequent but shorter rest periods between shift changes whereas in *slow rotation* the rest periods are less frequent but longer. *Fast rotation* schedules are thought to be slightly less disruptive to the shift worker's biological circadian rhythm as the body remains resolutely diurnal.¹⁸ What is considered to be *fast rotation* varies, for example between Europe and the USA.

In terms of the *direction of shift rotation*, *backward rotation* is used to describe shift work schedules which start with a period of working the night shift, then the afternoon shift and lastly the morning shift. In *forward rotation*, the morning shift is first, then the afternoon shift and then the night shift. *Forward rotation* is generally considered to be more suited to biological circadian rhythms.¹⁸

Shift schedules which include weekends as part of the normal working week are referred to as *continuous*. Under *discontinuous* shift work, there is no weekend working or it is taken as overtime.

Regular shift systems rely on a fixed basic pattern with blocks of different types of shift. *Irregular* shift systems are more ad hoc with many different shifts in the same week.

Self-scheduling

Self-scheduling enables individual shift workers to have some control over which shifts they work, shift start times, or when rest days occur. The extent of flexibility over shift patterns within *self-scheduling* systems varies by organisation.

4.1 The effects of the Compressed Working Week (CWW)

Forty separate studies examined the health and wellbeing effects of CWW interventions (Summary results tables 1-4, Appendix 4 and Full results table 8, Appendix 5).[39-88] The majority of CWW studies examined changes to four days of 12-hour shifts although some examined changes to 10-hour shifts,[39-41, 61, 62, 65, 88] and a few the introduction of the Ottawa shift system (Box 3).[42, 82] Thirty-four of the studies involved cohorts of which 23 were prospective. Summary table 1 summarises the results of the five prospective cohort studies with control groups,[39-43] Summary table 2 presents data from the other prospective studies and Summary table 3 synthesises the retrospective data. Given the relatively large evidence base, we have focused our synthesis on the more robust studies (that is, the prospective cohorts with control groups) and those with larger sample sizes. Most of the CWW studies were based in one of four distinct occupational settings: health care organisations (9), the police force (8), manufacturing companies (11) and energy industries (9). Results stratified by these settings are presented for the prospective cohort studies only in Summary tables 4a-4d - although there were few notable differences. No studies were found relating to other key shift working occupations such as retail or entertainment workers.[25] In a sizeable number of the CWW studies, the intervention was either at the behest of the work force [39-41, 46, 52, 54, 55, 64, 73, 74, 87] or from the management out of a desire to improve health or wellbeing.[42, 55, 66-68, 70, 75, 78, 83, 84, 86] However, in other studies, the motivation was more obviously efficiency or productivity.[51, 53, 56, 58, 59, 63, 65, 71, 81, 82, 85] Unfortunately, some studies provided little information about the

background to or detail about the implementation of the intervention and so it was not possible to ascertain the exact extent to which the CWW schedules were followed. [43-45, 47-50, 57, 60-62, 69, 72, 76, 77, 79, 80, 88]

Health: Effects of CWW on physical and mental health and wellbeing

The five prospective cohort studies with control groups [39-44] provide inconclusive evidence on the health effects of the CWW compared to the traditional pattern of five days of shifts and two days off (Summary table 1). In four of the five studies, some health improvements were recorded. [39-43] In one Canadian study of 30 police officers,[39, 40] health behaviour in the form of sporting activities improved in the intervention group compared to the control group but sickness absence rates did not change significantly. In another study of 70 UK police officers,[42] all but one (sleep quality) of the health indicators improved in the intervention group: General Health Questionnaire scores, lack of sleep, fatigue, headaches, stomach aches, sleep duration, stress, and feeling unwell, all improved. However, in this study the critical appraisal process identified notable differences in health at baseline between the control and intervention groups.

In a small Swedish study of 46 chemical plant workers,[43] sleep quality was generally better in the intervention group: ease of falling asleep and sleep quality improved. However, changes in fatigue, sufficient levels of sleep and general health did not differ from the control group at follow up. In terms of study quality there were queries about the suitability of the control group, and a lack of adjustment for confounders or non-response (Summary table 1). In a

Canadian study of 85 young male mineworkers, [41] sleep problems and tiredness showed no difference between the intervention and control groups but levels of sickness absence decreased substantially (a reduction of 73% in the intervention group compared to only 2% in the control group) as did the number of accidents (reduction of 69% in the intervention group compared to only 10% in the control group). The critical appraisal of this study [41] suggested that the sample may not be representative; the baseline and follow-up responses were also low and there was a lack of adjustment for confounders or non-response (Summary table 1).

In the other study,[44] of 45 UK police officers, health did not improve: chronic fatigue, physical health and GHQ-12 scores did not differ between the intervention and the control group at follow up, and the significant improvement in sleep duration in the intervention group disappeared when shift work experience was taken into account. This study was not notably different from the other prospective cohort studies in terms of methodological quality.

Although these studies were robust in terms of study design (employing a pcontrol group) the sample sizes were small, ranging from 23 to 85, and the lengths of follow-up were relatively short. No study followed up respondents for at least a year which may be the optimum as it allows for the possibility of controlling for possible seasonal effects.

The other prospective studies (Summary table 2) were also inconclusive, as whilst the majority identified an improvement in one or another of the various

health outcomes they measured, they also found little effect for others.[48-50, 54, 55, 57, 59, 61-63, 66-69, 72, 88] For example, Williams' study of 131 male chemical plant workers [54] recorded improvements in some measures such as depression but found no change or a detrimental change in other health-related outcomes such as absence from work. A number of studies of varying methodological quality and sample size reported no changes in any of the health indicators.[45, 51, 58, 60, 70] Other studies were more conclusive finding significant improvements in sleep duration,[47] absence,[52] physiological distress, fatigue and stress,[53] sleep between shifts, sleep difficulties, and health disorders.[64] In all these studies, employees were either involved in the design and implementation of the intervention or they were supportive of the change. Importantly, only two studies, both based in health care settings, found that all the different measures of health used worsened after the introduction of the CWW.[46, 56]

These studies are also limited in terms of length of follow-up and size. Only 3 studies had lengths of follow-up of 12 months or more, and the studies were small (tending to involve 15 to 50 participants). The largest study (n=104) (Johnson and Sharit, 2001 [64]) did (as noted above) find improvements in sleep and tiredness.

The results were similar for the retrospective studies (a less robust study design) with only a minority reporting any significant intervention effect (Summary table 3). [76, 77, 82-87] The majority of the significant effects though were positive, particularly in terms of general health and morbidity;[76, 77, 82] headaches, gastric upset, diarrhoea, and alcohol problems; [76, 77]

sleep;[78] and injuries.[83-85] One of the larger and better quality retrospective studies [76, 77] reported a significant decrease in age standardised morbidity ratio amongst men (from 1.02 to 0.47) but a non-significant decrease in women from (0.76 to 0.67).

Summary

On the whole, the evidence of effects on health of CWW are somewhat inconclusive: The prospective cohort studies with a control group suggest that the positive effects of the CWW on sleep amount and quality are not translated into better mental health. However, the prospective cohort studies without a control group are suggestive that CWW may improve actual mental health. Given that the critical appraisal process raised concerns about (i) the sample sizes and (ii) the overall quality of the prospective studies with control groups (including the use of inappropriate control groups and the existence of differences between groups at baseline), and given that there is disagreement between the overall findings of the controlled and uncontrolled studies, we can conclude the effects of CWW on sleep and mental health are as yet unclear, and warrant further study, in large controlled studies ideally with participants followed up over 12 months.

Wellbeing: Effects of CWW on work/life balance and the psychosocial work environment

Three of the five prospective cohort studies with control groups (Summary table 1) recorded significant improvements in wellbeing amongst the intervention group compared to the control group.[39, 40, 42, 43] In the Barton-Cunningham study of 30 Canadian police officers,[39, 40] all four of the indicators of wellbeing used in the study were significantly improved in the intervention group: Time spent on domestic chores, time spent on family matters, time spent with spouse, and time spent socialising with friends all improved. Furthermore, these improvements all disappeared when the old 8 hour schedule was restored. [39, 40] Similarly, in the Totterdell and Smith study of 70 UK police officers [42] all wellbeing indicators were improved in the intervention group (reductions were recorded in: insufficient time for family, insufficient time for friends, insufficient time for social life, personal life disrupted, planning social life difficult, domestic arrangements difficult, poor relations with family, and not enough free time). However, there are significant differences between the intervention and control groups at baseline which suggests that the findings need replicated in larger, studies with well-matched control groups.

The Swedish study of 46 chemical plant workers [43] also saw significant improvements in wellbeing, with both time for social/family activities and satisfaction with working hours increasing amongst the intervention group. There are some issues (as above) about the suitability of the non-randomised, non-matched control group (see Summary Table 1).

The other prospective study with a control group of 45 UK police officers [44] found no changes in wellbeing (workload, work pace control, social domestic interference) once shift work experience had been taken into consideration. Similarly, the study of 85 mineworkers [41] found no differences between the intervention and control groups for the wellbeing measures of tensions due to job, tensions due to people, tensions due to job characteristics, or family satisfaction. Importantly though none of the prospective cohort studies with control groups identified a decrease in wellbeing after the implementation of the CWW interventions. As noted above, these studies tended to employ relatively short periods of follow-up and small samples, and so despite the controlled design, the evidence they present is suggestive rather than convincing.

Consistently, the prospective uncontrolled studies, include two of the studies with at least 12 months of follow-up, (Summary table 2), found that aspects of wellbeing also improved after the introduction of CWW interventions.[45, 46, 51, 53, 54, 58, 59, 66-69, 72] Work/life balance indicators (such as time available for recreation, time spent with family, or conflict between work and non-work time) improved in eight studies, [45, 46, 51, 53, 54, 58, 59, 66-69, 72] whilst indicators of the psychosocial work environment (such as workload, job control or staff autonomy) showed signs of improvement in two .[46, 58] Some smaller and less methodologically-robust studies (e.g. low response and follow-up rates, no adjustment for non-response or confounders) did not identify any changes in wellbeing as a result of the intervention. [52, 55, 57]

Only four studies, [46, 48-50, 56, 59] of which all but one were identified by the critical appraisal process [56] to be of questionable methodological quality (e.g. small sample size, low response and follow-up rates, no adjustment for non-response or confounders, or unsubstantiated conclusions), reported any decreases in wellbeing and in three of these less robust studies only one or two aspects of wellbeing declined whilst others improved [46, 59] or were unaffected.[48-50]

In all of the retrospective studies that measured the effects of CWW interventions on wellbeing, it was found to improve.[78, 81, 82, 86] Leisure time and time spent with partner, [78] quality of life [81] and family life, [82] and child care [86] for example were all reported to improve. However, the critical appraisal process suggested that these studies had some methodological problems, in particular low baseline response rates,[81, 82] low or no follow up response rates, [78, 81, 82, 86] and little adjustment for non-response or confounders.[78, 81, 82, 86]

Summary

Overall, the methodologically more sound prospective studies (with or without a control group, and including those with longer periods of follow-up) found that the introduction of CWW improved wellbeing, especially in terms of work/life balance.

Economic: Effects of CWW on individual and organisational performance

Three of the prospective cohort studies with control groups (Summary table 1) also measured effects on performance (job satisfaction or effectiveness at work).[39-42] None found any significant differences between the intervention and control groups. Similarly, in the other prospective cohort studies (Summary table 2) the majority of the sixteen that measured economic outcomes found no effect although several reported improvements; in morale,[58, 66-68] job satisfaction, [53, 64, 65] productivity and quality [64] or organisational effectiveness.[53] However, four studies reported adverse economic effects such as an increase in turnover,[46] decreased job satisfaction [56] or decreased performance.[63, 71] Amongst the five retrospective studies which had reported economic or organisational outcomes,[80-84, 86] four identified benefits in terms of reduced staff costs and errors, [83, 84, 86] productivity,[81] or morale. [82]

Summary

Overall, the balance of best evidence suggests that there were few positive or negative effects on the economic outcomes, though it is possible that negative findings in this field may not have been published or may be otherwise unavailable (for example, for reasons of commercial confidentiality).

4.2 Studies of schedule redesign

Twenty-six studies of interventions were included in which the interventions involved redesigning the nature of shift work schedules (Summary tables 5-7, Appendix 4; Full results table 9, Appendix 5). [89-112] Seven studies reported on the health and wellbeing effects of interventions which altered the rotation of shifts in terms of changing the speed of rotation (e.g. from fast to slow rotation),[89-92] the direction of rotation (e.g. from forward to backward)[93, 94] or by removing rotation from shift work schedules altogether (Box 3).[95, 96] The results of these studies are presented in Summary table 5. Summary table 6 details the eleven studies which examined other aspects of schedule redesign such as changes to night work, [97-99] the introduction of later or more flexible shift times,[100] or self-scheduling. [104-106] Summary table 7 summarises the results of nine studies in which multiple changes to shift work schedules occurred. [97, 107-114] One study was a crossover trial,[93] and there were twenty cohort studies all of which were prospective and of which twelve had a control group. In some of the studies, the schedule redesign was undertaken with the health and wellbeing of employees in mind and thereby tended to follow ergonomic criteria.[91-93, 96, 99-101, 105, 106, 110, 111, 114] However, other changes were introduced for organisational/managerial reasons (for example, in order to increase productivity).[37, 89, 90, 94, 97, 98, 107, 108] Twelve studies were conducted in manufacturing settings, four in health care organizations, three were of transport workers and seven related to emergency services personnel. As with the CWW interventions, no studies of retail or entertainment workers were located.[25]

Speed of rotation

Three small prospective studies examined the health and wellbeing effects of changing the speed of shift rotation (Summary table 5).[89-92] All examined the effects of changing from slow to fast rotation (in each study, the switch to fast rotation consisted of a change from 6 or 7 consecutive shifts of the same form to a maximum of 3 [89, 90, 92] or 4 [91]) and all reported positive health effects. In one German prospective cohort study with a control group of 50 chemical processing workers,[89, 90] fatigue, sleep disturbances, and appetite disturbances all improved in the intervention group. However, no differences between the control and intervention groups were found for gastro-intestinal problems, and some complaints (i.e. hot flushes, sweating) actually worsened. In a small prospective cohort study of 39 traffic controllers in the Netherlands,[91] sleep complaints, although there were no changes in levels of fatigue. Similarly, in an Australian prospective repeat cross-sectional study of 26 emergency control room operators,[92] physical and mental health indicators improved (sleep difficulties, absence, headaches, digestive disorders, high blood pressure, diarrhoea, constipation, anxiety, and nervousness) but there were no significant effects on health behaviours (alcohol, caffeine and cigarette consumption were unchanged).

A similar pattern emerged for the wellbeing outcomes with most studies of changes to the speed of rotation reporting improvements or no change in wellbeing. In the chemical processing study,[89, 90] disturbance to social and family life improved when working the morning shifts, but there were no

differences when on the afternoon or night shifts. In the study of traffic controllers,[91] domestic and child care problems, workload, and satisfaction with evening leisure time all improved. However, complaints about leisure time remained unchanged and satisfaction with days off actually decreased. In the Australian study,[92] work pressure improved, but the other nine indicators of wellbeing remained unchanged.

It is difficult to comment with any confidence on the economic effects of changing from a slow to a fast rotating shift schedule as only one small (n=26) study,[92] (a repeat cross-sectional study), provided any information. This study reported an increase in levels of job satisfaction after the intervention.

Seven of the studies of the effects of multiple interventions (Summary table 7)[107-110, 112-114] also examined the effects of changing from a slow to a fast rotation. However, these interventions occurred alongside other concurrent interventions: moving from discontinuous to continuous working,[109] reduction in hours of the working week,[108] changing from backward to forward rotation; [107, 113, 114] or the simultaneous introduction various other changes.[110, 112] Therefore, the effects of any single intervention cannot be disentangled.

Summary

Overall, the studies of the speed of rotation suggest that changing from a slow to a fast shift rotation tended to improve health and wellbeing outcomes, though the small studies suggest caution in interpretation.

Direction of rotation

Two studies of single interventions examined changes in the direction of rotation (Summary table 5).[93, 94]

One study,[93] a crossover trial of 45 Swedish police officers, examined the effects of changing from backward to forward rotation. It found that some coronary risk factors (triglycerides and serum glucose, but not cholesterol levels or serum uric acid levels), mean systolic blood pressure, and mean sleep quality and duration during the day shift, all improved during the intervention period whereas mean diastolic blood pressure, sleep quality and duration on the night shift, and tobacco consumption were unchanged during the intervention phase, and self-rated health actually worsened. However, for the latter outcome there were very short periods of follow up of only three and five weeks.

Another study,[94] a prospective cohort study with a control group of 263 male car production workers, examined the opposite switch - from forward to backward rotation. It reported a mix of health effects with health behaviour

indicators, cigarette and alcohol consumption improving in the intervention group compared to the control group, whilst general health measures (Sleep quality on morning and night shifts, GHQ 12, chronic fatigue, gastrointestinal symptoms, sleep difficulties, duration and onset times) were no different in the intervention group, and sleep quality on afternoon shift days actually worsened ($F=4.85$, $p<.01$).

In terms of wellbeing, both of the single-intervention studies found some improvements, such as in satisfaction with the amount of leisure time [93] or social disruption,[94] but generally wellbeing was not different after the interventions. Job dissatisfaction, the only economic indicator measured, was unaffected.[94]

Summary

One high quality study found improvements in health-related outcomes as a result of changing from backward to forward rotation. However, the wellbeing effects were less clear.

Removal of shift work rotation

Two prospective cohort studies of police officers in the USA, one with a control group [95] and one without,[96] examined the removal of shift work rotation (the change from a rotating to a permanent shift system) as a single intervention (Summary table 5). One of the multiple intervention studies [97]

examined the removal of rotation alongside changes to the speed of rotation (Summary table 7).

The single methodologically-sound intervention study with a control group included 239 police officers [95] and reported an improvement in sleep but all other health indicators (trouble digesting, on the job tiredness, appetite problems, general health, smoking, drinking and headaches) were unchanged. In the other study of 63 police officers,[96] all of the health indicators improved significantly after the intervention: sleep quality and duration improved; psychological symptoms decreased in number and severity of symptoms; and sickness absence decreased.

In terms of wellbeing and economic outcomes, the study with a control group [95] provided rather mixed results as whilst spousal satisfaction improved in the intervention group compared to the control group, satisfaction with the opportunity to use abilities decreased but less in the intervention group than the control group, and a number of other wellbeing indicators were unaffected (Summary table 5). Similarly, whilst productivity increased (number of arrests and tickets issued increased by 6% in the intervention group), job satisfaction was no different.

Summary

The evidence base is small and somewhat inconclusive with few negative or positive effects on health, wellbeing or economic outcomes. The most robust study – a controlled study with 12 months and relatively large sample size follow-up - suggested few significant effects of removal of shiftwork rotation on health or wellbeing.[95]

Changes to night work

Three studies each examined slightly different changes to the nature of night work (Summary table 6), though the evidence is again limited by small sample sizes and/or short periods of follow-up.[97-99]

One study, a sizeable (n=305) prospective cohort with a control group and 12 months follow-up,[97] examined the removal of night shifts in a Swedish steel factory and found that sleep/mood and gastrointestinal complaints improved although there were no changes in shift specific health problems, sleep length or sickness absence. Wellbeing, measured as number of social complaints, also improved in the intervention group compared to the control group. No economic outcomes were measured.

In a prospective cohort of 76 UK police officers,[98] a reduction in the number of consecutive night shifts on the Ottawa system was examined. It reported

that night shift fatigue and sleepiness worsened. Caffeine use was unchanged. However the small sample and short length of follow-up limited the generalisability of the findings.

Another much smaller (n=18) but well-conducted prospective cohort study, this time of Japanese nurses,[99] examined the effects of increasing the rest period before the rotation onto night shift. This study suggested that although the intervention enabled an increase in sleep before the night shift, there was no change in irritation or tiredness once the night shift began.

Summary

The current evidence base on the health effects of changes to night working is diverse, small and generally weak- three uncontrolled studies of three slightly different interventions conducted in three different settings – and so it is not possible to offer any real conclusions about the effects on health and wellbeing. The largest study with 12 months follow-up suggests there may be some improvements in sleep and general wellbeing.

Later start and finish times

One larger study (Summary table 6) examined the introduction of later start and finish times to the shifts of 208 workers in a Finnish steel mill.[100] Changes in the rates of health complaints and chronic fatigue were no different in the intervention group compared to the control group, although the

sleep indicators were more mixed with improvements only in sleep duration on the evening shifts, satisfaction with the amount of sleep on the morning shifts, and awakening refreshed from sleep on the morning shifts. Work/life balance worsened, interference of shift work with domestic activities increased, but workload was unchanged in the intervention group. Similarly, there were no differences between the intervention and control groups in terms of job satisfaction. The critical appraisal also suggested that some observed changes may actually be due to differences between the control and intervention groups at baseline, and the length of follow-up is short (4 months).

One of the studies of multiple interventions (Summary table 7) [112] examined the introduction of later start and finish times. However this occurred alongside changes to both the speed and direction of rotation so it is not really possible to isolate the specific effects of later start and finish times.

Summary

There is a small evidence base of only one short-term study, reporting inconclusive effects on health-related outcomes, and a worsening of work/life balance.

Changes to weekend working

One methodologically-sound (n=101) prospective controlled study examined the switch from continuous (weekends on) to discontinuous (weekends off) shift work (Summary table 6).[101] The change was introduced to make the shift schedule more ergonomically-acceptable for the 101 nurses in a Danish hospital. HDL cholesterol worsened in the intervention group but total and LDL cholesterol improved. No other outcomes more directly relevant to health were reported.

A multiple-intervention study,[97] in which a concurrent change to the speed of rotation occurred, also examined this type of intervention. It was not possible to isolate any unique effect of the change to discontinuous working, and the critical appraisal suggested that the intervention and control groups may not be comparable.

One small, well-conducted, retrospective study from 1956 [102] examined the extension of shift working to cover weekends (a change from discontinuous to continuous shift work). The study, of 73 wives of UK steel workers, reported only on wellbeing outcomes (social life, domestic routine, time with husband) which were unaffected by the move to weekend working. A small (n=52) prospective multiple-intervention study [109] also examined this intervention, although it occurred alongside a change from slow to fast rotation and so its positive findings on sleep cannot be solely attributed to the change to continuous working. Conversely, though, it was possible for the authors to link a decrease in the economic wellbeing of the workers to the introduction of

continuous working on the basis that weekend overtime payments ceased. There were some methodological problems with this study (See Summary Table 8).

Summary

Very little relevant, robust evidence was located on the health, wellbeing or economic effects of changes to weekend shift work.

Decreased shift lengths

Two studies [37, 103] were identified in which the health and wellbeing effects of decreasing the length of shifts were examined. A small prospective cohort study (uncontrolled) which included 35 U.S. paramedics examined a reduction in average on-call shift length from 24 hours to 12 hours.[103] It found that emotional exhaustion improved significantly two months after the intervention (but this was not maintained at the 12 month follow-up), as did the impact of work schedule on social and family life. However, no effects were found for depersonalisation or job satisfaction.

In a retrospective cross-sectional study from 1933 of 265 female factory workers in the USA, [37] the change from 8hr to 6hr shifts had little effect on fatigue levels or on domestic life. However, the decreased working hours resulted in wage reductions for the majority of employees. However, the

critical appraisal process raised a number of questions about the quality of the study (Summary table 6) and the generalisability of such an old study is also questionable.

Summary

Only a partial (old/small) evidence base was found, from which it is not possible to draw any firm conclusions about the health and wellbeing effects of reducing shift length.

Self-scheduling

Three small prospective studies examined the introduction of self-scheduling amongst shift workers.[104-106] In all three of the studies, the intervention was introduced to improve working conditions. The two prospective cohorts with control group studies examined bus drivers,[104, 105] whilst a repeat cross sectional study focused on 45 nursing staff at a UK hospital.[106] Health and wellbeing outcomes were almost universally improved in all three: absence, fatigue, complaints about family life, and support from managers improved in the study of 50 bus drivers in the Netherlands,[104] accidents decreased by 20% and opportunities to plan leisure time, and social contacts improved in the study of 24 German bus drivers,[105] whilst work/life balance was also better in the hospital based study.[106] Only complaints about free time and time spent with the children in the Netherlands study were

unimproved by the intervention.[104] Similarly, in the two studies which measured economic outcomes,[104, 105] there were improvements in the number of productive work hours (from 50% to 54% of hours)[104] and the number of customer complaints (decreased by 52%).[105]

Two of the studies of multiple interventions (Summary table 7)[110, 112] also incorporated aspects of self-scheduling. However, self-scheduling was one of three or four different concurrent changes in both studies so they cannot be used as evidence of the effects of self-scheduling interventions.

Summary

All three studies found that self-scheduling improved health and wellbeing. However, given the small size of the studies, the focus on only two different occupational settings, and the lack of control group in any of the studies, more robust research is needed to add weight to and reinforce this conclusion.

4.3 Critical appraisal: summary

Although the 66 studies reviewed represent the best available evidence on the health and wellbeing effects of changing the organisation of shift work, they were subject to a number of methodological and other limitations.

The most obvious is that the majority of studies are small, and/or short-term; for example, if we were to limit the review to studies with 12 months of follow-up and sample sizes >100 participants, we would be limited to eight studies overall. (Although 100 is an arbitrary selection, it is probably a generous one; for example small changes in the percentage of participants experiencing sleep problems – say a reduction from 73% to 64%, as was observed in the Poole (1982) study – require a sample size of >400; effect sizes for other outcomes may be smaller than this and thus even larger samples are required). We therefore elected to include all studies, but to note the larger, longer-term studies. Similarly, while the outcomes varied in terms of validity – with few well-validated scales used, we included all studies, as for many of the outcomes there seemed little grounds for excluding studies on the basis that outcomes were self-reported (social functioning, or general health outcomes). Ideally, given a larger pool of better evidence to draw upon, it would have been possible to include only large, controlled studies with validated and reliable scales. Similarly including only studies with objective physiological corroboration of outcomes, large sample and longer follow-up would probably have limited the review to a single study (Yamada et al., 2001).

The most well-known and well-validated measure of general mental health, the GHQ, was used in 5 studies, and in 2 of these there was a significant effect of the intervention on GHQ score; however these studies were limited in other respects (small samples and/or focussed on short-term effects).

Methodological limitations

Only one trial (as opposed to controlled and uncontrolled observational studies) was found.[93] Whilst the schedule redesign interventions were often evaluated using a prospective cohort with a control group design, only five such studies existed for the CWW intervention.[39-44] Importantly, although many studies had a control group, these were usually not matched, and in at least one case there were significant differences in health and wellbeing at baseline between the intervention and control groups.[42] Amongst the schedule redesign studies, a sizeable number reported on the effects of concurrent (multiple) interventions, thereby preventing any isolation of the individual effects of an intervention (such as fast to slow rotation) on health or wellbeing.

As noted above this was the first systematic review of the evidence on the health and wellbeing effects of changing the organisation of shift work (as opposed to a review of purely descriptive studies) we elected to include all studies regardless of sample size. However, it needs to be noted that a number of studies were based on such small final sample sizes that their value in informing policy may in some cases be limited. For example, twelve studies had final sample sizes of 20 or fewer,[55, 57-62, 72, 83, 84, 86, 88,

99, 112, 113] and there was one study with only 3 participants.[60] This was particularly an issue in terms of the evidence base relating to the effects of CWW interventions and so in our synthesis, we therefore highlighted the larger studies. The number of small studies also raises the possibility that any positive findings may be due to publication bias, in which small studies with positive findings are more likely to be published (or are otherwise more easily located by reviewers) than those with negative findings. Similarly, publication bias may have arisen as we were only able to locate studies in the public domain thus excluding the majority of commercial studies. For example, studies with more “positive” findings may have been more likely to appear in academic publications or to be otherwise made publicly available; studies which found negative impacts may have remained unavailable and would not have been located by this review.

The health, wellbeing and economic measures were usually self-reported and they varied greatly from study to study. Few studies looked at the economic effects of such interventions and those that did, usually employed indirect or self-reported measures such as job satisfaction. Similarly, there was a dearth of well-validated questionnaires, such as the General Health Questionnaire, [42, 44, 57, 69, 72, 94] the Standard Shift work Index,[44] or the Work Environment Scale.[46] The lengths of follow up were generally 12 months or less and so it was usually not possible to analyse the longer term health or wellbeing effects of the shift work interventions which may be particularly important in terms of accumulated fatigue and physical health. The short

follow ups may also account for the lack of a health effect (either positive or negative) observed in the majority of the CWW studies.

Background information and information on implementation in studies of shift work

There was also relatively little information provided in some studies (as noted in Summary tables 1-3 and 5-7) about the background to the interventions or how they had been implemented. Indeed, disappointingly, the more methodologically-sound studies (at least in terms of study design) seemed to be those least likely to reveal details about the implementation of the intervention.[39-44, 93, 94] Conversely, some of the smaller, retrospective studies often provided a great deal of detail.[73, 74, 78, 83-85, 87] This lack of information on the fidelity of implementation means that in most cases we cannot be certain about the extent to which interventions were actually implemented on a day-to-day basis. In those studies which reported background details, those in which the intervention was instigated by employees or the motivation was employee wellbeing, tended to be more likely to report positive health and wellbeing effects, whilst the effects of those which were the most overtly driven by economic motives appeared to be often negative or negligible. [37, 51, 56, 58, 59, 63, 65, 71, 81, 94, 98, 107] We intend to analyse these implementation issues separately using data from this systematic review as well as other reviews of employment interventions.[115, 116]

5. CONSIDERATIONS/ISSUES FOR POLICY

5.1 Effects of the interventions

Overall, most of the types of organisational shift work intervention examined in this systematic review appear to have either neutral or positive health and wellbeing effects (see Box 4).

No one type of organisational intervention was found to be consistently harmful to workers. However, some negative effects on health and wellbeing were identified by the studies. In one study night shift fatigue and sleepiness worsened when the number of consecutive night shifts was decreased on the Ottawa system.[98] In another study, sleep quality and satisfaction with the amount of sleep decreased with the introduction of later start and finish times whilst schedule interference with domestic life increased.[100] HDL cholesterol levels worsened in one study of the introduction of discontinuous shift work, though this in itself is not a “health” outcome.[101] Satisfaction with opportunity to use abilities decreased in one study of changing from a rotating to a permanent shift system.[95] Some minor complaints,[89, 90] and satisfaction with days off,[91] and nervousness [92] were reported to worsen with the change from slow to fast shift rotation. Self-rated health decreased after a change to forward shift rotation;[93] and a decrease in sleep quality in the afternoon accompanied a change to backward rotation.[94] Individual studies of the introduction of the CWW noted the worsening of exercise rates,[48-50] sleep depth,[55] dissatisfaction with fatigue, child care, time spent with family, personal life, and job satisfaction,[56] health complaints,

cardiovascular complaints, anxiety, anger-frustration, and fatigue,[46] gastro-intestinal symptoms and work demands,[59] sleep duration during the day, tiredness and daytime performance,[63] absence,[65] sleep difficulties after night shift and minor aches and pains,[66-68] fatigue and performance,[71] and absence.[72] It should be noted though that only two studies found only negative intervention effects. [46, 56]

Four types of intervention though were found to have particularly beneficial effects: CWW, changing rotation from slow to fast or from backward to forward, and self-scheduling of shifts.

Compressed Work Week

The evidence for the effects of the CWW interventions on health was not conclusive: a number of studies reported some improvements in workforce health,[39-43, 47-50, 52-55, 57, 59, 61-64, 66-69, 71, 72, 76-78, 82-88] whilst others found no change,[44, 45, 51, 58, 60, 70, 73-75, 79-81] and two found only negative effects.[46, 56]

Shift work is often associated with fatigue (decline in mental and/or physical performance that results from prolonged exertion, sleep loss and/or disruption of the internal clock).[18, 20, 25] It might be expected that CWW, due to the longer working day, the potential for moonlighting, or excessive overtime, might further increase problems of fatigue amongst shift workers. Eighteen of the intervention studies synthesized in this review measured fatigue or tiredness: in only four was there an adverse change after the introduction of

CWW,[46, 56, 63, 71] three studies recorded improvements,[42, 53, 59] and in the other eleven there was no intervention effect.[41, 43-45, 51, 69, 72, 75, 80, 81, 86] The introduction of longer working days under CWW does not appear to adversely affect fatigue, however, this may well be because of the extended rest period which means that the normal weekly working hours are not exceeded in a seven day period.[38] However, it may also be due to the popularity of CWW interventions amongst workers [44] (as they increase leisure time and/or enable moonlighting) and this may bias the findings of evaluations in a positive direction, especially in studies with a short follow-up period. Subsequently, it is therefore important that safeguards such as the EU working time directive or other measures which limit the negative effects of new shifts bans on overtime and moonlighting, are incorporated. In the latter case this may include some assessment of the likely effects of the new schedule on risk and fatigue. The HSE's Fatigue/Risk indices are likely to be important in this respect as these provide a tool for comparing shift patterns, and identifying the main sources of risk/fatigue within particular shift patterns (See: <http://www.hse.gov.uk/research/rrhtm/rr446.htm>).

Overall therefore, the evidence base on the health effects of CWW interventions is perhaps best described as “cautiously positive”; “positive” because whilst the CWW interventions might not always improve the health of shift workers, they appear to be seldom detrimental; “cautious” because of the methodological limitations outlined in the text; and because in two hospital-based prospective cohort studies, [46, 56] the introduction of the CWW had only negative effects on health (increases in health complaints,

cardiovascular complaints, anxiety, anger-frustration, and fatigue [46] or dissatisfaction with fatigue [56]); caution is also indicated because there may be a short-term 'happy worker' effect due to the popularity of CWW interventions.[44]

Box 4: Summary of effects by intervention

Compressed Work Week

- *Health (40 studies)*
Cautiously positive: interventions do not always improve health but they are seldom detrimental.
- *Wellbeing (24 studies)*
Fairly conclusive: implementation of CWW improves wellbeing especially in terms of work/life balance.
- *Economic (23 studies)*
Interventions have negligible positive or negative effects.

Schedule redesign

- Speed of rotation (12 studies)
Health and wellbeing improvements for change from backward to forward rotation, no effects for change from forward to backward rotation. Positive economic effects.
- Direction rotation (8 studies)
Positive health and wellbeing effects for switch from slow to fast rotation. No economic effects
- Removal of rotation (3 studies)
Some improvements in health. Mixed wellbeing and economic effects with some positive, some negative and some negligible.
- Changes to night work (3 studies)
Inconclusive with mixed effects for all three outcomes
- Later start and finish times (2 studies)
Few health effects. Wellbeing worsened or unchanged. No economic effects.
- Changes to weekend working (4 studies)
Some improvements in health and wellbeing. Negative economic effect in one study.
- Decreased hours (2 study)
Health and wellbeing improved in one study. Negative economic effect in the other study.
- Self-scheduling (5 studies)
Health and wellbeing improved. Positive economic effects.

In contrast, the evidence about the effects of CWW interventions on the wellbeing of shift workers seems more conclusive (although the comments about the influence of the popularity of the intervention still apply): CWW appears to improve wellbeing, especially in terms of work/life balance. The majority of studies which examined wellbeing outcomes noted improvements after the introduction of CWW,[39, 40, 42, 43, 45, 46, 51, 53, 54, 58, 59, 66-69, 72, 78, 81, 82, 86], with only a few reporting no intervention effect [41, 44, 52, 55, 57] or a worsening in wellbeing.[46, 48-50, 56, 59] Most improvement was recorded in the work/life balance outcomes, such as time spent with family.[45, 51, 53, 54, 59, 66-69, 72] The popularity of CWW amongst shift workers is largely because they value the additional days off that are afforded by the CWW model.[44] Indeed, in 22 of the 40 CWW studies, the intervention was either specifically requested by the employees or implemented with their support.

The results of the CWW studies suggest a consistent link between improved social wellbeing and improved health. Three prospective studies with control groups, [39, 40, 42, 43] six of the prospective studies without a control group [53, 54, 59, 66-69, 72] and three of the retrospective studies reporting increases in social wellbeing,[78, 82, 86] also reported improvements in health (Summary tables 1-3 and 5-7). On the whole the wellbeing indicators which improved related to work/life balance whilst the health improvements related to mental health. For example, in one prospective cohort study reductions in physiological distress, fatigue and stress accompanied improvements in schedule inference with personal life and life satisfaction;

[53] whilst in another study there were improvements in conflict between work and non-work time and planning activities with family as well as depression.[54] Changes in physical health measures were less associated with changes in social wellbeing. For example, improvements in absence,[41, 52] accidents,[41] gastro-intestinal problems,[48-50, 57] sleep and fatigue,[55, 57] and loss of appetite, headaches, irritability, heart problems and GHQ,[56] occurred despite no accompanying changes in wellbeing. This tentatively suggests that whilst changes in mental or physical health and social wellbeing can clearly occur separately, positive changes in social wellbeing, particularly work/life balance, can translate into positive mental health effects. The relationship between social wellbeing and physical health however is less clear. This link and possible causal pathway should be examined further in future prospective studies.

Generally the studies suggested that the economic effects of the CWW were small or absent with most studies finding no evidence of either benefit or detriment to organisational and individual performance.[39-42, 47, 52, 54, 57, 59, 69, 70, 72, 80]

Overall then, the evidence presented in this review suggests that the CWW can improve the work/life balance of shift workers, and it may do so at a low risk of adverse health or economic effects, though it is important to take measures to identify and mitigate the most likely adverse effects (such as increases in fatigue and risk).

Schedule redesign: Slow to fast speed of shift rotation

The studies of interventions which redesigned shift work schedules so that they used fast rather than slow rotation reported unanimously positive health effects.[89-92] This is in keeping with the broader epidemiological and laboratory based research literature, in which fast rotations have been shown to be less disruptive to the natural circadian rhythm and therefore potentially less damaging to health.[18] Introducing fast rotation into schedules therefore perhaps negates some of the negative health effects of shift work. Although somewhat less conclusive, the evidence suggested that wellbeing also generally improved with the introduction of fast rotating schedules.[89-92] Any economic effects appeared to be positive, but the evidence is very limited.[92]

Schedule redesign: Backward to forward direction of shift rotation

Epidemiological and laboratory studies have also suggested that changing the direction of shift schedules from backward to forward rotation is more in keeping with the body's circadian rhythm, and that therefore positive health effects could ensue, especially in terms of sleep.[18, 20, 111, 117] Only one intervention study, a crossover trial, was located which examined the change from backward to forward rotation, and it confirmed this view.[93] Most of the coronary risk factors measured (e.g. cholesterol levels), and sleep duration improved after the change to a forward rotating schedule. However, in a study of the opposite switch (from forward to backward),[94] health did not worsen

significantly although sleep on the mid-rotation afternoon shift decreased. Backward to forward rotation had no notable impact on wellbeing and no economic factors were measured.

Schedule redesign: Self-scheduling of shifts

Health (absence, fatigue, accidents), wellbeing (support from managers, work/life balance, complaints about family life, social contacts, planning leisure time), and economic effectiveness (productive work hours, customer complaints) were all positively enhanced in all three of the studies which examined the introduction of self-scheduling amongst shift workers.[104-106] Self-scheduling necessarily entails increasing employee control at work, something which has been strongly associated in the epidemiological literature, most notably by the Whitehall Studies,[5, 12-15] and other systematic reviews of work reorganisation interventions,[115, 116] with improved health and wellbeing. In line with such research, the intervention studies included in this review suggest that, even amongst specific occupational groups such as shift workers, increasing control can have beneficial health, social, and economic effects.

5.2 Research implications

This systematic review reinforces previous research showing that the organisation of work is an important area for public health research and policy development.[5, 8-10, 12-16] Furthermore, changing the organisation of work can have positive health and wellbeing effects: The evidence synthesis has suggested that certain interventions (particularly CWW, slow to fast rotation,

backward to forward rotation, or self-scheduling) which change the organisation of shift work, can be beneficial to the health and wellbeing of workers, though as is often the case, larger, more robust studies are needed to confirm this observation.

Box 5: Summary of research implications

- Partial evidence base:
 - Unclear what the effects of changing the organisation of shift work are on health inequalities, although as shift work is concentrated amongst lower occupational groups it is plausible that effective interventions for shift workers in general, such as CWW, could reduce the gap in health between manual and non-manual workers.
 - Little evidence on the effects of interventions on health behaviours.
- Methodological limitations of studies:
 - Few trials or studies with adequate control groups
 - Self-reported outcomes and little use of validated questionnaires
 - Small sample sizes
 - Short follow up periods
 - Concurrent interventions common in studies of schedule redesign
- Background and implementation:
 - Few details of the background to the intervention, particularly in the better designed studies
 - Implementation seldom discussed
- Future research:
 - Prospective, well controlled studies, which describe the background to the study and the implementation of the intervention, are needed.
 - Studies which examine the longer term health effects of CWW interventions and any interaction with changes in wellbeing would be the most useful.

The evidence base on changing the organisation of shift work is relatively large by systematic review standards, both in terms of the intervention studies synthesised in this research report (66 in total), and the wider descriptive epidemiological literature.[20, 23, 30-32] However, there are still some large evidence gaps, most notably in terms of any effects of shift work interventions on inequalities in health amongst working age populations. The majority of studies were conducted in fairly homogeneous populations (e.g. male production workers, or female nurses) and, perhaps in part due to this, only one study differentiated outcomes by gender,[76, 77] one by age,[113] and none of the studies differentiated by occupational grade or socio-economic group. The one retrospective study which differentiated results by gender, [76, 77] found a decrease in total morbidity amongst men but not women after the introduction of a CWW. A small prospective cohort study of changes to rotation [113] which compared outcomes by age, found that sleep quality improved in older workers compared to younger workers.

A key question remains as to whether changing the organisation of shift work has the potential to decrease health inequalities amongst the working age population. An important consideration in this respect is the social patterning of shift work in the UK, which tends to be concentrated amongst workers from lower socio-economic groups (with the notable exceptions of medical and emergency services staff).[26] This contributes to the generally poorer, more health-damaging work environment experienced by manual compared to non-manual workers. It is plausible that interventions which improve the health and wellbeing of shift workers may therefore, on the whole, help to reduce the gap

in health between manual and non-manual workers caused by the differences in working conditions between the two groups. This possibility could be explored further.

There is also little evidence on the effects of organisational-level changes to the nature of shift work on the health behaviours of workers. Only four of the forty CWW studies examined health behaviours. Two studies reported on the effects on exercise with one reporting an increase,[39, 40] whilst the other found no change;[55] one study reported an increase in alcohol consumption,[72] and another found no intervention effect on the consumption of social drugs.[57] Four of the single intervention schedule redesign studies reported on alcohol and cigarette consumption,[92-95] but in only one prospective cohort study with a control group [94] of a change from forward to backward rotation were any significant effects found (an increase in consumption of both alcohol and tobacco). Importantly, the high quality crossover trial of backward-to-forward rotation found no significant effect on tobacco consumption. [93]

In addition, the research studies reviewed were also subject to a number of methodological limitations such as poorly-matched control groups, differences at baseline, concurrent interventions, lack of detail about implementation, small sample sizes and short periods of follow-up. Prospective, well-controlled studies, which use widely validated questionnaires (such as the General Health Questionnaire), and which describe the background to the study and the implementation of the intervention,[118] are needed. Studies which

examine the mental health effects of CWW interventions and any interaction with changes in sleep or social wellbeing would perhaps be the most useful.

There have now been a number of systematic reviews and other authoritative overviews of the health and wellbeing effects of changes to the nature of work, as well as reviews commissioned by the HSE and others on the association between working life and general wellbeing.[22, 115, 116, 119] However, many of these have been academic in focus, and it may now be timely to draw together this evidence base into a non-academic overview, in order to provide a broader picture of the policy and practice implications of the effects of work organisation on health and wellbeing. This would provide a summary of current “best evidence” in order to support employment policy and practice.

5.3 Potential policy implications

The results of this systematic review suggest that some interventions which change the organisation of shift work, can positively affect the health and wellbeing of employees, whilst others have little effect. Specifically, the evidence suggests that introducing the Compressed Work Week is potentially beneficial to wellbeing and enhances work/life balance for shift workers. It is also generally beneficial, or at least not detrimental, to health in the short term. Self-scheduling also emerges as a positive intervention which enhances the health and wellbeing of employees. Similarly, less operationally disruptive interventions, such as changing the rotation of shift work from backward to forward or from slow to fast, can also be beneficial to occupational health.

Future guidance to employers about the effects of changing the organisation of shift work should reflect these positive effects. Importantly, these types of intervention tend to have either positive or negligible economic effects (although work reorganisation itself will inevitably entail costs) and so health and wellbeing may be improved through the workplace without necessarily damaging productivity or competitiveness (though it should also be noted that negative effects may be under-reported). This message can be a useful aid in implementing the recent cross-departmental Health and Safety Executive, Department of Health and Department for Work and Pensions' 'Health, Work and Wellbeing' [120] strategy amongst employers: Changing shift work organisation and working practices to make them 'healthier' or more conducive to a work/life balance does not necessarily carry an economic warning.

6. CONCLUSION

This report has presented the results of a systematic review of the health and wellbeing effects of interventions which alter the organisation of shift work. It has found that such interventions are seldom health-damaging and can often have positive wellbeing effects. Four types of intervention in particular have been suggested to be beneficial:

- (1) Self-scheduling of shifts, which were reported to have positive health, wellbeing and economic effects.

- (2) CWW which, whilst not always delivering health improvements, did fairly consistently enhance the wellbeing of shift workers, and did so without economic cost.
- (3) Changing from backward to forward rotation which, as suggested by epidemiological and laboratory studies, enhanced health.
- (4) Switching from slow to fast rotation, which, perhaps as a result of making shift work schedules less disruptive to circadian rhythms, had positive health and wellbeing effects.

There are however (as noted earlier) some reservations about the extent and quality of the evidence base on shift work reorganisation, which future studies should address. However, overall this systematic review suggests that organisational level workplace interventions can improve the health and wellbeing of shift workers. The workplace is therefore rightly considered by UK policymakers to be an important arena for health and wellbeing: It should remain as a priority for new interventions and regulation if the health of the public is to be maintained and improved.

7. ACKNOWLEDGEMENTS

We would like to thank the referees for their very helpful suggestions on earlier draft of this report, and Matt Egan, MRC Public and Health Sciences Unit, Glasgow. Mark Petticrew is funded by the Chief Scientist Office of the Scottish Department of Health.

8. APPENDICES

APPENDIX 1: Full search strategy

Databases

The following databases and websites were searched in November/December 2005:

- MEDLINE (1966-2005 Nov week 2) (OVID)
- MEDLINE In-Process & Other Non-Indexed Citations (November 16, 2005) (OVID)
- Embase (1980-2005 week 47) (OVID)
- HMIC Health Management Information Consortium (November 2005) (OVID)
- Psycinfo (1806-2005 November week 2) (OVID)
- International Bibliography of the Social Sciences (1951 – 2005 November week 03) (OVID)
- EconLit (1969-2005/10) (WebSPIRS)
- PAIS International (Public Affairs Information Service) (1972-2005/09) (WebSPIRS)
- SIGLE (System for Information on Grey Literature in Europe) (1980-2005/03) (WebSPIRS)
- Social Science Citations Index (1956-2005 November 20th) (ISI Web of Knowledge)
- ASSIA (1987 – to date) (CSA)
- Sociological Abstracts (1963 – to date) (CSA)
- ERIC (1966 – to date) (CSA)
- Geobase (1980-16/11/05) (OCLC)
- Electronic Collections Online (1995-18/11/05) (OCLC)
- PapersFirst (1993-19/11/05) (OCLC)
- Management Contents (1983-2005/Nov 22) (Dialog)
- Index to Theses (1716-9/11/05) (<http://www.theses.com/>)
- Dissertation Abstracts (1861-to date) (UMI Proquest)
- JSTOR (last updated 17/11/05) (JSTOR)
- CORDIS (Community Research & Development Information Service) (<http://www.cordis.lu/en/home.html>)
- ESRC (Economic & Social Research Council) (<http://www.regard.ac.uk/ESRCInfoCentre/index.aspx>)
- EconPapers (<http://econpapers.repec.org/>)
- NTIS (National Technical Information Service) (<http://www.ntis.gov/index.asp?loc=2-0-0>)
- Harvard Business Review (<http://harvardbusinessonline.hbsp.harvard.edu/hbrsa/en/archive/archive.jhtml>)
- European Commission Libraries Catalogue (<http://europa.eu.int/eclas/>)
- Labordoc (<http://labordoc.ilo.org/>)

Concepts

It was initially suggested that three of the PICO concepts be included in the search: population (shiftwork), interventions and health outcomes. However, because the potential outcomes were vast and varied, it was decided to drop this part of the

search. It was felt that this would be an improvement as any outcome could potentially be of interest.

Terminology

A basic set of search terms covering each concept were agreed upon. The terms for the population (shiftwork) were quite specific, and arrived at by a combination of scanning 'gold-standard' papers and seeking shiftwork definitions (eg from Unison document). The decision was made to include slightly broader populations (overtime, flexitime and long working hours) as these were felt to possibly fall into the shiftwork category. Terms to cover interventions were more broad. Specific, named interventions such as napping, bright lights, were included, but it was felt that papers would exist that did not mention specific interventions, but referred to broader concepts such as 'structural change'. Therefore search strings were constructed to cover these possibilities, although a balance was sought whereby very broad terms ('change' as a single term) were not included, as this would vastly increase the yield of irrelevant papers.

These terms were then adapted for each individual database. The search strategy for each database is included below. This is to show the variation necessary to make each search efficient and productive for that database. Notes about specific strategies are included to clarify some of the search terms used.

Limits

No date or language limits were used. Animal studies were removed where possible.

Reference management

Records were loaded into Endnote software. For reasons of time, records were split between two Endnote libraries. Duplicates were removed. Total references:

Shiftwork one.enl 12035 refs

Shiftwork two deduplicated 1244 refs

Strategies

MEDLINE (1966-2005 Nov week 2) (OVID)

Searched 21/11/05.

3249 records retrieved

1. shiftwork\$.ti,ab.
2. nightwork\$.ti,ab.
3. ((shift or shifts) adj2 (work\$ or night\$)).ti,ab.
4. (night\$ adj2 work\$).ti,ab.
5. nightshift\$.ti,ab.
6. ((shift or shifts) adj2 (rota\$ or system or systems or schedule\$ or roster\$)).ti,ab.
7. ((shift or shifts) adj2 (extend\$ or pattern\$ or cycle\$)).ti,ab.

8. ((shift or shifts) adj2 (evening or late or early or weekend or twilight)).ti,ab.
9. (hour\$ adj (shift or shifts)).ti,ab.
10. ((shift or shifts) adj2 (continental or continuous or turnaround or split)).ti,ab.
11. ((nonstandard or non-standard) adj2 (work\$ or shift or shifts)).ti,ab.
12. ((unsocia\$ or antisocia\$ or anti-socia\$) adj2 (work\$ or shift or shifts)).ti,ab.
13. (irregular\$ adj2 (work\$ or shift or shifts)).ti,ab.
14. compressed work\$.ti,ab.
15. long work\$ hour\$.ti,ab.
16. (extend\$ adj (duty or duties or work\$) adj hour\$).ti,ab.
17. overtime.ti,ab.
18. (flextime or flex time or flexitime or flexi time).ti,ab.
19. (flex\$ adj work\$).ti,ab.
20. work schedule tolerance/
21. or/1-20
22. exp Legislation/
23. legislat\$.ti,ab.
24. (law or laws).ti,ab.
25. work\$ time directive.ti,ab.
26. ((eu or europe\$) adj3 work\$).ti,ab.
27. european union/
28. (european adj (commission or union)).ti,ab.
29. bright light\$.ti,ab.
30. (nap or naps or napped or napping).ti,ab.
31. clockwise.ti,ab.
32. (reorganis\$ or reorganiz\$ or re-organis\$ or re-organiz\$).ti,ab.
33. (restructur\$ or re-structur\$).ti,ab.
34. (entrain\$ or re-entrain\$).ti,ab.
35. (countermeasure\$ or surveillance).ti,ab.
36. (reschedul\$ or re-schedul\$ or redesign\$ or re-design\$).ti,ab.
37. ergonomic\$.ti,ab.
38. (self help or selfhelp).ti,ab.
39. (self schedul\$ or self roster\$).ti,ab.
40. program development/
41. (coping or cope\$).ti,ab.
42. exp counseling/
43. counsel\$.ti,ab.
44. empower\$.ti,ab.
45. circadian rhythm/
46. circadian.ti,ab.
47. phototherapy/
48. phototherap\$.ti,ab.
49. (light treatment or light therap\$).ti,ab.
50. Melatonin/
51. melatonin\$.ti,ab.
52. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
53. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
54. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
55. ((shift\$ or work\$ or hour\$) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
56. ((shift\$ or work\$ or hour\$) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or manag\$ or strateg\$)).ti,ab.

57. ((shift\$ or work\$ or hour\$) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
58. or/22-57
59. 21 and 58
60. animals/
61. humans/
62. 60 not (60 and 61)
63. 59 not 62

**MEDLINE In-Process & Other Non-Indexed Citations (November 16, 2005)
(OVID)**

Searched 21/11/05.

88 records retrieved

1. shiftwork\$.ti,ab.
2. nightwork\$.ti,ab.
3. ((shift or shifts) adj2 (work\$ or night\$)).ti,ab.
4. (night\$ adj2 work\$).ti,ab.
5. nightshift\$.ti,ab.
6. ((shift or shifts) adj2 (rota\$ or system or systems or schedule\$ or roster\$)).ti,ab.
7. ((shift or shifts) adj2 (extend\$ or pattern\$ or cycle\$)).ti,ab.
8. ((shift or shifts) adj2 (evening or late or early or weekend or twilight)).ti,ab.
9. (hour\$ adj (shift or shifts)).ti,ab.
10. ((shift or shifts) adj2 (continental or continuous or turnaround or split)).ti,ab.
11. ((nonstandard or non-standard) adj2 (work\$ or shift or shifts)).ti,ab.
12. ((unsocia\$ or antisocia\$ or anti-socia\$) adj2 (work\$ or shift or shifts)).ti,ab.
13. (irregular\$ adj2 (work\$ or shift or shifts)).ti,ab.
14. compressed work\$.ti,ab.
15. long work\$ hour\$.ti,ab.
16. (extend\$ adj (duty or duties or work\$) adj hour\$).ti,ab.
17. overtime.ti,ab.
18. (flextime or flex time or flexitime or flexi time).ti,ab.
19. (flex\$ adj work\$).ti,ab.
20. or/1-19
21. legislat\$.ti,ab.
22. (law or laws).ti,ab.
23. work\$ time directive.ti,ab.
24. ((eu or europe\$) adj3 work\$).ti,ab.
25. (european adj (commission or union)).ti,ab.
26. bright light\$.ti,ab.
27. (nap or naps or napped or napping).ti,ab.
28. clockwise.ti,ab.
29. (reorganis\$ or reorganiz\$ or re-organis\$ or re-organiz\$).ti,ab.
30. (restructur\$ or re-structur\$).ti,ab.
31. (entrain\$ or re-entrain\$).ti,ab.
32. (countermeasure\$ or surveillance).ti,ab.
33. (reschedul\$ or re-schedul\$ or redesign\$ or re-design\$).ti,ab.
34. ergonomic\$.ti,ab.
35. (self help or selfhelp).ti,ab.
36. (self schedul\$ or self roster\$).ti,ab.
37. (coping or cope\$).ti,ab.
38. counsel\$.ti,ab.
39. empower\$.ti,ab.
40. circadian.ti,ab.
41. phototherap\$.ti,ab.

42. (light treatment or light therap\$).ti,ab.
43. melatonin\$.ti,ab.
44. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
45. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
46. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
47. ((shift\$ or work\$ or hour\$) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
48. ((shift\$ or work\$ or hour\$) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or manag\$ or strateg\$)).ti,ab.
49. ((shift\$ or work\$ or hour\$) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
50. or/21-49
51. 20 and 50

Embase (1980-2005 week 47) (OVID)

Searched 21/11/05.

2836 records retrieved

1. shift worker/
2. shiftwork\$.ti,ab.
3. nightwork\$.ti,ab.
4. night work/
5. ((shift or shifts) adj2 (work\$ or night\$)).ti,ab.
6. (night\$ adj2 work\$).ti,ab.
7. nightshift\$.ti,ab.
8. ((shift or shifts) adj2 (rota\$ or system or systems or schedule\$ or roster\$)).ti,ab.
9. ((shift or shifts) adj2 (extend\$ or pattern\$ or cycle\$)).ti,ab.
10. ((shift or shifts) adj2 (evening or late or early or weekend or twilight)).ti,ab.
11. (hour\$ adj (shift or shifts)).ti,ab.
12. ((shift or shifts) adj2 (continental or continuous or turnaround or split)).ti,ab.
13. ((nonstandard or non-standard) adj2 (work\$ or shift or shifts)).ti,ab.
14. ((unsocia\$ or antisocia\$ or anti-socia\$) adj2 (work\$ or shift or shifts)).ti,ab.
15. (irregular\$ adj2 (work\$ or shift or shifts)).ti,ab.
16. compressed work\$.ti,ab.
17. long work\$ hour\$.ti,ab.
18. (extend\$ adj (duty or duties or work\$) adj hour\$).ti,ab.
19. overtime.ti,ab.
20. (flextime or flex time or flexitime or flexi time).ti,ab.
21. (flex\$ adj work\$).ti,ab.
22. work schedule/
23. or/1-22
24. law/
25. (law or laws).ti,ab.
26. legislat\$.ti,ab.
27. work\$ time directive.ti,ab.
28. ((eu or europe\$) adj3 work\$).ti,ab.
29. european union/
30. (european adj (commission or union)).ti,ab.
31. bright light\$.ti,ab.
32. (nap or naps or napped or napping).ti,ab.
33. clockwise.ti,ab.
34. (reorganis\$ or reorganiz\$ or re-organis\$ or re-organiz\$).ti,ab.

35. (restructur\$ or re-structur\$).ti,ab.
36. (entrain\$ or re-entrain\$).ti,ab.
37. (countermeasure\$ or surveillance).ti,ab.
38. (reschedul\$ or re-schedul\$ or redesign\$ or re-design\$).ti,ab.
39. ergonomics/
40. ergonomic\$.ti,ab.
41. self help/
42. (self help or selfhelp).ti,ab.
43. (self schedul\$ or self roster\$).ti,ab.
44. program development/
45. (coping or cope\$).ti,ab.
46. counseling/
47. counsel\$.ti,ab.
48. empower\$.ti,ab.
49. Circadian Rhythm/
50. circadian.ti,ab.
51. phototherapy/
52. phototherap\$.ti,ab.
53. (light treatment or light therap\$).ti,ab.
54. Melatonin/
55. melatonin\$.ti,ab.
56. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
57. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
58. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
59. ((shift\$ or work\$ or hour\$) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
60. ((shift\$ or work\$ or hour\$) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
61. ((shift\$ or work\$ or hour\$) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
62. or/24-61
63. 23 and 62
64. (cat or cats or dog or dogs or animal or animals or rat or rats or hamster or hamsters or feline or ovine or bovine or canine or sheep).ti,ab.
65. exp animal/
66. animal experiment/
67. nonhuman/
68. or/64-67
69. human/
70. human experiment/
71. 69 or 70
72. 68 not (68 and 71)
73. 63 not 72

HMIC Health Management Information Consortium (November 2005) (OVID)
Searched 21/11/05.
363 records retrieved

1. exp shift work/
2. shiftwork\$.ti,ab.
3. night work/
4. nightwork\$.ti,ab.

5. ((shift or shifts) adj2 (work\$ or night\$)).ti,ab.
6. (night\$ adj2 work\$).ti,ab.
7. nightshift\$.ti,ab.
8. ((shift or shifts) adj2 (rota\$ or system or systems or schedule\$ or roster\$)).ti,ab.
9. ((shift or shifts) adj2 (extend\$ or pattern\$ or cycle\$)).ti,ab.
10. ((shift or shifts) adj2 (evening or late or early or weekend or twilight)).ti,ab.
11. (hour\$ adj (shift or shifts)).ti,ab.
12. ((shift or shifts) adj2 (continental or continuous or turnaround or split)).ti,ab.
13. ((nonstandard or non-standard) adj2 (work\$ or shift or shifts)).ti,ab.
14. exp unsocial hours/
15. ((unsocia\$ or antisocia\$ or anti-socia\$) adj2 (work\$ or shift or shifts)).ti,ab.
16. (irregular\$ adj2 (work\$ or shift or shifts)).ti,ab.
17. compressed work\$.ti,ab.
18. long work\$ hour\$.ti,ab.
19. (extend\$ adj (duty or duties or work\$) adj hour\$).ti,ab.
20. overtime/
21. overtime hours/
22. overtime.ti,ab.
23. flexible working/
24. flexible working hours/
25. (flextime or flex time or flexitime or flexi time).ti,ab.
26. (flex\$ adj work\$).ti,ab.
27. or/1-26
28. exp legislation/
29. legislat\$.ti,ab.
30. exp law/
31. (law or laws).ti,ab.
32. work\$ time directive.ti,ab.
33. ((eu or europe\$) adj3 work\$).ti,ab.
34. european union/
35. european union directives/
36. (european adj (commission or union)).ti,ab.
37. bright light\$.ti,ab.
38. (nap or naps or napped or napping).ti,ab.
39. clockwise.ti,ab.
40. exp reorganisation/
41. exp organisational change/
42. (reorganis\$ or reorganiz\$ or re-organis\$ or re-organiz\$).ti,ab.
43. (restruct\$ or re-structur\$).ti,ab.
44. (entrain\$ or re-entrain\$).ti,ab.
45. (countermeasure\$ or surveillance).ti,ab.
46. (reschedul\$ or re-schedul\$ or redesign\$ or re-design\$).ti,ab.
47. ergonomics/
48. ergonomic\$.ti,ab.
49. self help/
50. (self help or selfhelp).ti,ab.
51. (self schedul\$ or self roster\$).ti,ab.
52. (coping or cope\$).ti,ab.
53. exp counselling/
54. counsel\$.ti,ab.
55. empowerment/
56. empower\$.ti,ab.
57. exp circadian rhythm/
58. circadian.ti,ab.
59. light phototherapy/

60. phototherap\$.ti,ab.
61. (light treatment or light therap\$).ti,ab.
62. melatonin/
63. melatonin\$.ti,ab.
64. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
65. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
66. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
67. ((shift\$ or work\$ or hour\$) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
68. ((shift\$ or work\$ or hour\$) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
69. ((shift\$ or work\$ or hour\$) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
70. or/28-69
71. 27 and 70

Psycinfo (1806-2005 November week 2) (OVID)

Searched 21/11/05.

1482 records retrieved

1. workday shifts/
2. shiftwork\$.ti,ab.
3. nightwork\$.ti,ab.
4. ((shift or shifts) adj2 (work\$ or night\$)).ti,ab.
5. (night\$ adj2 work\$).ti,ab.
6. nightshift\$.ti,ab.
7. ((shift or shifts) adj2 (rota\$ or system or systems or schedule\$ or roster\$)).ti,ab.
8. ((shift or shifts) adj2 (extend\$ or pattern\$ or cycle\$)).ti,ab.
9. ((shift or shifts) adj2 (evening or late or early or weekend or twilight)).ti,ab.
10. (hour\$ adj (shift or shifts)).ti,ab.
11. ((shift or shifts) adj2 (continental or continuous or turnaround or split)).ti,ab.
12. ((nonstandard or non-standard) adj2 (work\$ or shift or shifts)).ti,ab.
13. ((unsocia\$ or antisocia\$ or anti-socia\$) adj2 (work\$ or shift or shifts)).ti,ab.
14. (irregular\$ adj2 (work\$ or shift or shifts)).ti,ab.
15. compressed work\$.ti,ab.
16. long work\$ hour\$.ti,ab.
17. (extend\$ adj (duty or duties or work\$) adj hour\$).ti,ab.
18. overtime.ti,ab.
19. (flextime or flex time or flexitime or flexi time).ti,ab.
20. (flex\$ adj work\$).ti,ab.
21. or/1-20
22. exp government policy making/
23. legislative processes/
24. legislat\$.ti,ab.
25. (law or laws).ti,ab.
26. work\$ time directive.ti,ab.
27. ((eu or europe\$) adj3 work\$).ti,ab.
28. (european adj (commission or union)).ti,ab.
29. bright light\$.ti,ab.
30. napping/
31. (nap or naps or napped or napping).ti,ab.
32. clockwise.ti,ab.

33. (reorganis\$ or reorganiz\$ or re-organis\$ or re-organiz\$).ti,ab.
34. (restructur\$ or re-structur\$).ti,ab.
35. exp organizational change/
36. (entrain\$ or re-entrain\$).ti,ab.
37. (countermeasure\$ or surveillance).ti,ab.
38. (reschedul\$ or re-schedul\$ or redesign\$ or re-design\$).ti,ab.
39. ergonomic\$.ti,ab.
40. exp self help/
41. (self help or selfhelp).ti,ab.
42. (self schedul\$ or self roster\$).ti,ab.
43. exp program development/
44. (coping or cope\$).ti,ab.
45. coping behavior/
46. exp counseling/
47. counsel\$.ti,ab.
48. empowerment/
49. empower\$.ti,ab.
50. human biological rhythms/
51. circadian.ti,ab.
52. phototherapy/
53. phototherap\$.ti,ab.
54. (light treatment or light therap\$).ti,ab.
55. melatonin/
56. melatonin\$.ti,ab.
57. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
58. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).ti,ab.
59. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
60. ((shift\$ or work\$ or hour\$) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).ti,ab.
61. ((shift\$ or work\$ or hour\$) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or manag\$ or strateg\$)).ti,ab.
62. ((shift\$ or work\$ or hour\$) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).ti,ab.
63. or/22-62
64. 21 and 63
65. animal.po.
66. human.po.
67. 65 not (65 and 66)
68. 64 not 67

International Bibliography of the Social Sciences (1951 – 2005 November week 03) (OVID)

Searched 21/11/05.

274 records retrieved

1. shiftwork\$.mp.
2. nightwork\$.mp.
3. ((shift or shifts) adj2 (work\$ or night\$)).mp.
4. (night\$ adj2 work\$).mp.
5. nightshift\$.mp.
6. ((shift or shifts) adj2 (rota\$ or system or systems or schedule\$ or roster\$)).mp.
7. ((shift or shifts) adj2 (extend\$ or pattern\$ or cycle\$)).mp.

8. ((shift or shifts) adj2 (evening or late or early or weekend or twilight)).mp.
9. (hour\$ adj (shift or shifts)).mp.
10. ((shift or shifts) adj2 (continental or continuous or turnaround or split)).mp.
11. ((nonstandard or non-standard) adj2 (work\$ or shift or shifts)).mp.
12. ((unsocia\$ or antisocia\$ or anti-socia\$) adj2 (work\$ or shift or shifts)).mp.
13. (irregular\$ adj2 (work\$ or shift or shifts)).mp.
14. compressed work\$.mp.
15. long work\$ hour\$.mp.
16. (extend\$ adj (duty or duties or work\$) adj hour\$).mp.
17. overtime.mp.
18. (flextime or flex time or flexitime or flexi time).mp.
19. (flex\$ adj work\$).mp.
20. or/1-19
21. legislat\$.mp.
22. (law or laws).mp.
23. work\$ time directive.mp.
24. ((eu or europe\$) adj3 work\$).mp.
25. (european adj (commission or union)).mp.
26. bright light\$.mp.
27. (nap or naps or napped or napping).mp.
28. clockwise.mp.
29. (reorganis\$ or reorganiz\$ or re-organis\$ or re-organiz\$).mp.
30. (restructur\$ or re-structur\$).mp.
31. (entrain\$ or re-entrain\$).mp.
32. (countermeasure\$ or surveillance).mp.
33. (reschedul\$ or re-schedul\$ or redesign\$ or re-design\$).mp.
34. ergonomic\$.mp.
35. (self help or selfhelp).mp.
36. (self schedul\$ or self roster\$).mp.
37. (coping or cope\$).mp.
38. counsel\$.mp.
39. empower\$.mp.
40. circadian.mp.
41. phototherap\$.mp.
42. (light treatment or light therap\$).mp.
43. melatonin\$.mp.
44. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).mp.
45. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or strateg\$)).mp.
46. ((structur\$ or organis\$ or organiz\$ or management or managerial) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).mp.
47. ((shift\$ or work\$ or hour\$) adj3 (chang\$ or modif\$ or design\$ or intervention\$)).mp.
48. ((shift\$ or work\$ or hour\$) adj3 (impact\$ or alter\$ or adapt\$ or measure\$ or manag\$ or strateg\$)).mp.
49. ((shift\$ or work\$ or hour\$) adj3 (reduc\$ or increas\$ or particip\$ or educat\$ or train\$ or program\$)).mp.
50. or/21-49
51. 20 and 50

EconLit (1969-2005/10) (WebSPIRS)

Searched 21/11/05.

278 records retrieved

1. shiftwork*
2. nightwork*
3. (shift or shifts) near2 (work* or night*)
4. night* near2 work*
5. nightshift*
6. (shift or shifts) near2 (rota* or system or systems or schedule* or roster*)
7. (shift or shifts) near2 (extend* or pattern* or cycle*)
8. (shift or shifts) near2 (evening or late or early or weekend or twilight)
9. (hour* shift) or (hour* shifts)
10. (shift or shifts) near2 (continental or continuous or turnaround or split)
11. (nonstandard or non-standard) near2 (work* or shift or shifts)
12. (unsocia* or antisocia* or anti-socia*) near2 (work* or shift or shifts)
13. irregular* near2 (work* or shift or shifts)
14. compressed work*
15. long work* hour*
16. extend* near (duty or duties or work*) near hour*
17. overtime
18. flextime or flex time or flexitime or flexi time
19. flex* work*
20. #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19
21. legislat*
22. law or laws
23. work* time directive
24. (eu or europe*) near3 work*
25. (european commission) or (european union)
26. bright light*
27. nap or naps or napped or napping
28. clockwise
29. reorganis* or reorganiz* or re-organis* or re-organiz*
30. restructur* or re-structur*
31. entrain* or re-entrain*
32. countermeasure* or surveillance
33. reschedul* or re-schedul* or redesign* or re-design*
34. ergonomic*
35. self help or selfhelp
36. self schedul* or self roster*
37. coping or cope*
38. counsel*
39. empower*
40. circadian
41. phototherap*
42. light treatment or light therap*
43. melatonin*
44. (structur* or organis* or organiz* or management or managerial) near3 (chang* or modif* or design* or intervention*)
45. (structur* or organis* or organiz* or management or managerial) near3 (impact* or alter* or adapt* or measure* or strateg*)
46. (structur* or organis* or organiz* or management or managerial) near3 (reduc* or increas* or particip* or educat* or train* or program*)
47. (shift* or work* or hour*) near3 (chang* or modif* or design* or intervention*)
48. (shift* or work* or hour*) near3 (impact* or alter* or adapt* or measure* or manag* or strateg*)
49. (shift* or work* or hour*) near3 (reduc* or increas* or particip* or educat* or train* or program*)

- 50. #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49
- 51. #20 and #50

**PAIS International (Public Affairs Information Service) (1972-2005/09)
(WebSPIRS)**

Searched 21/11/05.

173 records retrieved

- 1. shiftwork*
- 2. nightwork*
- 3. (shift or shifts) near2 (work* or night*)
- 4. night* near2 work*
- 5. nightshift*
- 6. (shift or shifts) near2 (rota* or system or systems or schedule* or roster*)
- 7. (shift or shifts) near2 (extend* or pattern* or cycle*)
- 8. (shift or shifts) near2 (evening or late or early or weekend or twilight)
- 9. (hour* shift) or (hour* shifts)
- 10. (shift or shifts) near2 (continental or continuous or turnaround or split)
- 11. (nonstandard or non-standard) near2 (work* or shift or shifts)
- 12. (unsocia* or antisocia* or anti-socia*) near2 (work* or shift or shifts)
- 13. irregular* near2 (work* or shift or shifts)
- 14. compressed work*
- 15. long work* hour*
- 16. extend* near (duty or duties or work*) near hour*
- 17. overtime
- 18. flextime or flex time or flexitime or flexi time
- 19. flex* work*
- 20. #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19
- 21. legislat*
- 22. law or laws
- 23. work* time directive
- 24. (eu or europe*) near3 work*
- 25. (european commission) or (european union)
- 26. bright light*
- 27. nap or naps or napped or napping
- 28. clockwise
- 29. reorganis* or reorganiz* or re-organis* or re-organiz*
- 30. restructur* or re-structur*
- 31. entrain* or re-entrain*
- 32. countermeasure* or surveillance
- 33. reschedul* or re-schedul* or redesign* or re-design*
- 34. ergonomic*
- 35. self help or selfhelp
- 36. self schedul* or self roster*
- 37. coping or cope*
- 38. counsel*
- 39. empower*
- 40. circadian
- 41. phototherap*
- 42. light treatment or light therap*
- 43. melatonin*

44. (structur* or organis* or organiz* or management or managerial) near3 (chang* or modif* or design* or intervention*)
45. (structur* or organis* or organiz* or management or managerial) near3 (impact* or alter* or adapt* or measure* or strateg*)
46. (structur* or organis* or organiz* or management or managerial) near3 (reduc* or increas* or particip* or educat* or train* or program*)
47. (shift* or work* or hour*) near3 (chang* or modif* or design* or intervention*)
48. (shift* or work* or hour*) near3 (impact* or alter* or adapt* or measure* or manag* or strateg*)
49. (shift* or work* or hour*) near3 (reduc* or increas* or particip* or educat* or train* or program*)
50. #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49
51. #20 and #50

**SIGLE (System for Information on Grey Literature in Europe) (1980-2005/03)
(WebSPIRS)**

Searched 21/11/05.

86 records retrieved

1. shiftwork*
2. nightwork*
3. (shift or shifts) near2 (work* or night*)
4. night* near2 work*
5. nightshift*
6. (shift or shifts) near2 (rota* or system or systems or schedule* or roster*)
7. (shift or shifts) near2 (extend* or pattern* or cycle*)
8. (shift or shifts) near2 (evening or late or early or weekend or twilight)
9. (hour* shift) or (hour* shifts)
10. (shift or shifts) near2 (continental or continuous or turnaround or split)
11. (nonstandard or non-standard) near2 (work* or shift or shifts)
12. (unsocia* or antisocia* or anti-socia*) near2 (work* or shift or shifts)
13. irregular* near2 (work* or shift or shifts)
14. compressed work*
15. long work* hour*
16. extend* near (duty or duties or work*) near hour*
17. overtime
18. flextime or flex time or flexitime or flexi time
19. flex* work*
20. #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19
21. legislat*
22. law or laws
23. work* time directive
24. (eu or europe*) near3 work*
25. (european commission) or (european union)
26. bright light*
27. nap or naps or napped or napping
28. clockwise
29. reorganis* or reorganiz* or re-organis* or re-organiz*
30. restructur* or re-structur*
31. entrain* or re-entrain*
32. countermeasure* or surveillance
33. reschedul* or re-schedul* or redesign* or re-design*

34. ergonomic*
35. self help or selfhelp
36. self schedul* or self roster*
37. coping or cope*
38. counsel*
39. empower*
40. circadian
41. phototherap*
42. light treatment or light therap*
43. melatonin*
44. (structur* or organis* or organiz* or management or managerial) near3 (chang* or modif* or design* or intervention*)
45. (structur* or organis* or organiz* or management or managerial) near3 (impact* or alter* or adapt* or measure* or strateg*)
46. (structur* or organis* or organiz* or management or managerial) near3 (reduc* or increas* or particip* or educat* or train* or program*)
47. (shift* or work* or hour*) near3 (chang* or modif* or design* or intervention*)
48. (shift* or work* or hour*) near3 (impact* or alter* or adapt* or measure* or manag* or strateg*)
49. (shift* or work* or hour*) near3 (reduc* or increas* or particip* or educat* or train* or program*)
50. #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49
51. #20 and #50

Social Science Citations Index (1956-2005 November 20th) (ISI Web of Knowledge)

Searched 22/11/05.

3259 records retrieved

1. TS=shiftwork* or TS=nightwork* or TS=nightshift* or TS=compressed work* or TS=long work* hour* or TS=overtime or TS=flextime or TS=flex time or TS=flexitime or TS=flexi time or TS=hour* shift or TS=hour* shifts or TS=flex* work*
2. TS=((shift or shifts) same (work* or night*))
3. TS=(night* same work*)
4. TS=((shift or shifts) same (rota* or system or systems or schedule* or roster* or extend* or pattern* or cycle*))
5. TS=((shift or shifts) same (evening or late or early or weekend or twilight or continental or continuous or turnaround or split))
6. TS=((nonstandard or non-standard or unsocia* or antisocia* or anti-socia* or irregular*) same (work* or shift or shifts))
7. TS=extend* duty hour* or TS=extend* duties hour* or TS=extend* work* hour*
8. #1 or #2 or #3 or #4 or #5 or #6 or #7
9. TS=legislat* or TS=law or TS=laws or TS=work* time directive or TS=european union or TS=european commission or TS=bright light* or TS=nap or TS=naps or TS=napped or TS=napping or TS=clockwise
10. TS=((eu or europe*) same work*)
11. TS=reorganis* or TS=reorganiz* or TS=re-organis* or TS=re-organiz* or TS=restructur* or TS=re-structur* or TS=entrain* or TS=re-entrain* or TS=countermeasure* or TS=surveillance
12. TS=reschedul* or TS=re-schedul* or TS=redesign* or TS=re-design* or TS=ergonomic* or TS=self help or TS=selfhelp or TS=self schedul* or TS=self roster*

13. TS=coping or TS=cope* or TS=counsel* or TS=empower* or TS=circadian or TS=phototherap* or TS=light treatment or TS=light therap* or TS=melatonin*
14. TS=((structur* or organis* or organiz* or management or managerial) same (chang* or modif* or design* or intervention*))
15. TS=((structur* or organis* or organiz* or management or managerial) same (impact* or alter* or adapt* or measure* or strateg*))
16. TS=((structur* or organis* or organiz* or management or managerial) same (reduc* or increas* or particip* or educat* or train* or program*))
17. TS=((shift* or work* or hour*) same (chang* or modif* or design* or intervention*))
18. TS=((shift* or work* or hour*) same (impact* or alter* or adapt* or measure* or manag* or strateg*))
19. TS=((shift* or work* or hour*) same (reduc* or increas* or particip* or educat* or train* or program*))
20. #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19
21. #8 and #20

ASSIA (1987 – to date) (CSA)

Searched 21/11/05.

243 records retrieved

((DE=("shiftwork" or "flexible shiftwork" or "night shifts")) or (kw=shiftwork* or nightwork* or nightshift*) or (kw=((shift or shifts) within 2 (work* or night*))) or (kw=(night* within 2 work*)) or (kw=((shift or shifts) within 2 (rota* or system or systems or schedule* or roster*))) or (kw=((shift or shifts) within 2 (extend* or pattern* or cycle*))) or (kw=((shift or shifts) within 2 (evening or late or early or weekend or twilight))) or (kw=hour* shift or hour* shifts) or (kw=((shift or shifts) within 2 (continental or continuous or turnaround or split))) or (kw=((nonstandard or non-standard) within 2 (work* or shift or shifts))) or (kw=((unsocia* or antisocia* or anti-socia*) within 2 (work* or shift or shifts))) or (kw=(irregular* within 2 (work* or shift or shifts))) or (kw=compressed work* or long work* hour*) or (kw=extend* duty hour* or extend* duties hour* or extend* work* hour*) or (kw=overtime or flexitime or flex time or flexitime or flexi time or flex* work*) or (DE="flexitime")) and ((DE=("legislation" or "acts of congress" or "acts of parliament" or "emergency legislation" or "parliamentary bills" or "retrospective legislation")) or (DE=("european union" or "common agricultural policy" or "european commission")) or (kw=legislat* or law or laws or work* time directive or european commission or european union) or (kw=((eu or europe*) within 3 work*)) or (DE="nap therapy") or (kw=bright light* or nap or naps or napped or napping or clockwise) or (DE=("reorganization" or "social reorganization")) or (DE=("restructuring" or "economic restructuring" or "employment restructuring" or "downsizing")) or (DE="organizational change") or (kw=reorganis* or reorganiz* or re-organis* or re-organiz* or restructur* or re-structur* or entrain* or re-entrain*) or (DE="countermeasures") or (DE=("surveillance" or "aerial surveillance")) or (DE=("ergonomics" or "heat stress" or "time study" or "activity sampling")) or (kw=countermeasure* or surveillance or reschedul* or re-schedul* or redesign* or re-design* or ergonomic*) or (DE="selfhelp") or (kw=self help or selfhelp or self schedul* or self roster*) or (DE=("cognitive coping" or "emotional coping")) or (DE=("coping skills" or "coping strategies" or "coping style")) or (DE=("cognitive behavioural counselling" or "computer assisted counselling" or "crosscultural counselling" or "educational guidance" or "group counselling" or "long term counselling" or "mandatory counselling" or "multicultural counselling" or "pastoral counselling" or "peer group counselling" or "selfcounselling" or "vocational counselling")) or (DE=("empowerment" or "disempowerment" or "psychological empowerment" or "selfempowerment")) or (kw=coping or cope* or counsel* or empower*) or (DE="circadian rhythms") or (DE="phototherapy") or (DE="melatonin") or (kw=circadian or phototherap* or light treatment or light therap* or melatonin*) or

(kw=((structur* or organis* or organiz* or management or managerial) within 3 (chang* or modif* or design* or intervention*))) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (impact* or alter* or adapt* or measure* or strateg*))) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (reduc* or increas* or particip* or educat* or train* or program*))) or (kw=((shift* or work* or hour*) within 3 (chang* or modif* or design* or intervention*))) or (kw=((shift* or work* or hour*) within 3 (impact* or alter* or adapt* or measure* or manag* or strateg*))) or (kw=((shift* or work* or hour*) within 3 (reduc* or increas* or particip* or educat* or train* or program*)))

Sociological Abstracts (1963 – to date) (CSA)

Searched 21/11/05.

678 records retrieved

((DE="shift work") or (kw=shiftwork* or nightwork* or nightshift*) or (kw=((shift or shifts) within 2 (work* or night*))) or (kw=(night* within 2 work*)) or (kw=((shift or shifts) within 2 (rota* or system or systems or schedule* or roster*))) or (kw=((shift or shifts) within 2 (extend* or pattern* or cycle*))) or (kw=((shift or shifts) within 2 (evening or late or early or weekend or twilight))) or (kw=hour* shift or hour* shifts) or (kw=((shift or shifts) within 2 (continental or continuous or turnaround or split))) or (kw=((nonstandard or non-standard) within 2 (work* or shift or shifts))) or (kw=((unsocia* or antisocia* or anti-socia*) within 2 (work* or shift or shifts))) or (kw=(irregular* within 2 (work* or shift or shifts))) or (kw=compressed work* or long work* hour*) or (kw=extend* duty hour* or extend* duties hour* or extend* work* hour*) or (kw=overtime or flextime or flex time or flexitime or flexi time or flex* work*)) and ((DE=("legislation" or "statutes")) or (DE="legislative bodies") or (kw=legislat* or law or laws or work* time directive or european commission or european union) or (kw=((eu or europe*) within 3 work*)) or (DE="european union") or (kw=bright light* or nap or naps or napped or napping or clockwise) or (kw=reorganis* or reorganiz* or re-organis* or re-organiz* or restructur* or re-structur* or entrain* or re-entrain*) or (DE="organizational change") or (kw=countermeasure* or surveillance or reschedul* or re-schedul* or redesign* or re-design* or ergonomic*) or (DE="surveillance") or (kw=self help or selfhelp or self schedul* or self roster*) or (DE="self help") or (kw=coping or cope* or counsel* or empower*) or (DE="coping") or (DE="counseling") or (kw=circadian or phototherap* or light treatment or light therap* or melatonin*) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (chang* or modif* or design* or intervention*))) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (impact* or alter* or adapt* or measure* or strateg*))) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (reduc* or increas* or particip* or educat* or train* or program*))) or (kw=((shift* or work* or hour*) within 3 (chang* or modif* or design* or intervention*))) or (kw=((shift* or work* or hour*) within 3 (impact* or alter* or adapt* or measure* or manag* or strateg*))) or (kw=((shift* or work* or hour*) within 3 (reduc* or increas* or particip* or educat* or train* or program*)))

ERIC (1966 – to date) (CSA)

Searched 21/11/05.

551 records retrieved

((kw=shiftwork* or nightwork* or nightshift*) or (kw=((shift or shifts) within 2 (work* or night*))) or (kw=(night* within 2 work*)) or (kw=((shift or shifts) within 2 (rota* or system or systems or schedule* or roster*))) or (kw=((shift or shifts) within 2 (extend* or pattern* or cycle*))) or (kw=((shift or shifts) within 2 (evening or late or early or weekend or twilight))) or (kw=hour* shift or hour* shifts) or (kw=((shift or shifts) within 2 (continental or continuous or turnaround or split))) or (kw=((nonstandard or non-

standard) within 2 (work* or shift or shifts))) or (kw=((unsocia* or antisocia* or anti-socia*) within 2 (work* or shift or shifts))) or (kw=(irregular* within 2 (work* or shift or shifts))) or (kw=compressed work* or long work* hour*) or (kw=extend* duty hour* or extend* duties hour* or extend* work* hour*) or (kw=overtime or flexitime or flex time or flexitime or flexi time or flex* work*) or (DE="overtime") or (DE="flexible working hours")) and ((DE=("legislation" or "labor legislation" or "local legislation" or "public health legislation" or "state legislation")) or (kw=legislat* or law or laws or work* time directive or european commission or european union) or (kw=((eu or europe*) within 3 work*)) or (kw=bright light* or nap or naps or napped or napping or clockwise) or (DE="program development") or (kw=reorganis* or reorganiz* or re-organis* or re-organiz* or restructur* or re-structur* or entrain* or re-entrain*) or (kw=countermeasure* or surveillance or reschedul* or re-schedul* or redesign* or re-design* or ergonomic*) or (kw=self help or selfhelp or self schedul* or self roster*) or (DE="program development") or (kw=coping or cope* or counsel* or empower*) or (DE="program development") or (DE=("adult counseling" or "career counseling" or "cocounseling" or "educational counseling" or "family counseling" or "group counseling" or "individual counseling" or "nondirective counseling" or "peer counseling")) or (kw=circadian or phototherap* or light treatment or light therap* or melatonin*) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (chang* or modif* or design* or intervention*)) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (impact* or alter* or adapt* or measure* or strateg*)) or (kw=((structur* or organis* or organiz* or management or managerial) within 3 (reduc* or increas* or particip* or educat* or train* or program*)) or (kw=((shift* or work* or hour*) within 3 (chang* or modif* or design* or intervention*)) or (kw=((shift* or work* or hour*) within 3 (impact* or alter* or adapt* or measure* or manag* or strateg*)) or (kw=((shift* or work* or hour*) within 3 (reduc* or increas* or particip* or educat* or train* or program*)))))

Geobase (1980-16/11/05) (OCLC)

Searched 21/11/05.

1241 records retrieved

(kw: shiftwork* or kw: nightwork* or kw: nightshift*) or ((kw: shift* n2 work) or (kw: shift* n2 work) or (kw: shift* n2 works) or (kw: shift* n2 works) or (kw: shift* n2 working) or (kw: shift* n2 worker*)) or ((kw: shift* n2 night*) or (kw: night* n2 work) or (kw: night* n2 works) or (kw: night* n2 worke*) or (kw: night* n2 working)) or ((kw: shift* n2 rota*) or (kw: shift* n2 system) or (kw: shift* n2 systems) or (kw: shift* n2 schedule*) or (kw: shift* n2 roster*)) or ((kw: shift* n2 extend*) or (kw: shift* n2 pattern*) or (kw: shift* n2 cycle*)) or ((kw: shift* n2 evening) or (kw: shift* n2 late) or (kw: shift* n2 early) or (kw: shift* n2 weekend) or (kw: shift* n2 twilight)) or ((kw: hour* n shift) or (kw: hour* n shifts)) or ((kw: shift* n2 continental) or (kw: shift* n2 continuous) or (kw: shift* n2 turnaround) or (kw: shift* n2 split)) or ((kw: shift* n2 nonstandard) or (kw: shift* n2 non-standard)) or ((kw: nonstandard n2 working) or (kw: non-standard n2 working) or (kw: unsocial n2 working) or (kw: antisocial n2 working) or (kw: anti-social n2 working)) or ((kw: antisocial n2 working) or (kw: anti-social n2 working) or (kw: antisocial n2 work) or (kw: anti-social n2 work) or (kw: antisocial n2 works) or (kw: anti-social n2 works)) or ((kw: unsocia* n2 shift*) or (kw: antisocia* n2 shift*) or (kw: anti-socia* n2 shift*)) or ((kw: irregular* n2 shift*) or (kw: irregular n2 work) or (kw: irregular n2 working)) or ((kw: compressed n work) or (kw: compressed n working)) or ((kw: long n work n hour*) or (kw: long n working n hour*)) or ((kw: extended n duty n hour*) or (kw: extended n work n hours*)) or (kw: overtime or kw: flexitime or (kw: flex n time) or kw: flexitime or (kw: flexi n time)) or ((kw: flex* n work) or (kw: flex* n working)) and ((kw: legislat* or kw: law or kw: laws) or (kw: working n time n directive) or ((kw: eu n3 work) or (kw: eu n3 working) or (kw: europe n3 work) or (kw: europe n3 working)) or ((kw: european n commission) or (kw:

european n union)) or ((kw: bright n light) or (kw: bright n lights) or (kw: bright n lighting)) or (kw: nap or kw: naps or kw: napped or kw: napping or kw: clockwise) or (kw: reorganis* or kw: reorganiz* or kw: re-organis* or kw: re-organiz*) or (kw: restructur* or kw: re-structur* or kw: entrain* or kw: re-entrain*) or (kw: countermeasure* or kw: surveillance or kw: ergonomic*) or (kw: reschedul* or kw: re-schedul* or kw: redesign* or kw: re-design*) or ((kw: self n help) or kw: selfhelp or (kw: self n schedul*) or (kw: self n roster*)) or (kw: coping or kw: cope* or kw: counsel* or kw: empower*) or (kw: circadian or kw: phototherap* or (kw: light n treatment) or (kw: light n therap*) or kw: melatonin*) or (kw: chang* or kw: modif* or kw: design* or kw: intervention* or kw: impact* or kw: alter* or kw: adapt* or kw: measure* or kw: manag* or kw: strateg* or kw: reduc* or kw: increas* or kw: particip* or kw: educat* or kw: train* or kw: program*))

Electronic Collections Online (1995-18/11/05) (OCLC)

Searched 21/11/05.

1822 records retrieved

(kw: shiftwork* or kw: nightwork* or kw: nightshift*) or ((kw: shift* n2 work) or (kw: shift* n2 work) or (kw: shift* n2 works) or (kw: shift* n2 works) or (kw: shift* n2 working) or (kw: shift* n2 worker*)) or ((kw: shift* n2 night*) or (kw: night* n2 work) or (kw: night* n2 works) or (kw: night* n2 worke*) or (kw: night* n2 working)) or ((kw: shift* n2 rota*) or (kw: shift* n2 system) or (kw: shift* n2 systems) or (kw: shift* n2 schedule*) or (kw: shift* n2 roster*)) or ((kw: shift* n2 extend*) or (kw: shift* n2 pattern*) or (kw: shift* n2 cycle*)) or ((kw: shift* n2 evening) or (kw: shift* n2 late) or (kw: shift* n2 early) or (kw: shift* n2 weekend) or (kw: shift* n2 twilight)) or ((kw: hour* n shift) or (kw: hour* n shifts)) or ((kw: shift* n2 continental) or (kw: shift* n2 continuous) or (kw: shift* n2 turnaround) or (kw: shift* n2 split)) or ((kw: shift* n2 nonstandard) or (kw: shift* n2 non-standard)) or ((kw: nonstandard n2 working) or (kw: non-standard n2 working) or (kw: unsocial n2 working) or (kw: antisocial n2 working) or (kw: anti-social n2 working)) or ((kw: antisocial n2 working) or (kw: anti-social n2 working) or (kw: antisocial n2 work) or (kw: anti-social n2 work) or (kw: antisocial n2 works) or (kw: anti-social n2 works)) or ((kw: unsocia* n2 shift*) or (kw: antisocia* n2 shift*) or (kw: anti-socia* n2 shift*)) or ((kw: irregular* n2 shift*) or (kw: irregular n2 work) or (kw: irregular n2 working)) or ((kw: compressed n work) or (kw: compressed n working)) or ((kw: long n work n hour*) or (kw: long n working n hour*)) or ((kw: extended n duty n hour*) or (kw: extended n work n hours*)) or (kw: overtime or kw: flextime or (kw: flex n time) or kw: flexitime or (kw: flexi n time)) or ((kw: flex* n work) or (kw: flex* n working)) and ((kw: legislat* or kw: law or kw: laws) or (kw: working n time n directive) or ((kw: eu n3 work) or (kw: eu n3 working) or (kw: europe n3 work) or (kw: europe n3 working)) or ((kw: european n commission) or (kw: european n union)) or ((kw: bright n light) or (kw: bright n lights) or (kw: bright n lighting)) or (kw: nap or kw: naps or kw: napped or kw: napping or kw: clockwise) or (kw: reorganis* or kw: reorganiz* or kw: re-organis* or kw: re-organiz*) or (kw: restructur* or kw: re-structur* or kw: entrain* or kw: re-entrain*) or (kw: countermeasure* or kw: surveillance or kw: ergonomic*) or (kw: reschedul* or kw: re-schedul* or kw: redesign* or kw: re-design*) or ((kw: self n help) or kw: selfhelp or (kw: self n schedul*) or (kw: self n roster*)) or (kw: coping or kw: cope* or kw: counsel* or kw: empower*) or (kw: circadian or kw: phototherap* or (kw: light n treatment) or (kw: light n therap*) or kw: melatonin*) or (kw: chang* or kw: modif* or kw: design* or kw: intervention* or kw: impact* or kw: alter* or kw: adapt* or kw: measure* or kw: manag* or kw: strateg* or kw: reduc* or kw: increas* or kw: particip* or kw: educat* or kw: train* or kw: program*))

PapersFirst (1993-19/11/05) (OCLC)

Searched 21/11/05.

281 records retrieved

(kw: shiftwork* or kw: nightwork* or kw: nightshift*) or ((kw: shift* n2 work) or (kw: shift* n2 work) or (kw: shift* n2 works) or (kw: shift* n2 works) or (kw: shift* n2 working) or (kw: shift* n2 worker*)) or ((kw: shift* n2 night*) or (kw: night* n2 work) or (kw: night* n2 works) or (kw: night* n2 worke*) or (kw: night* n2 working)) or ((kw: shift* n2 rota*) or (kw: shift* n2 system) or (kw: shift* n2 systems) or (kw: shift* n2 schedule*) or (kw: shift* n2 roster*)) or ((kw: shift* n2 extend*) or (kw: shift* n2 pattern*) or (kw: shift* n2 cycle*)) or ((kw: shift* n2 evening) or (kw: shift* n2 late) or (kw: shift* n2 early) or (kw: shift* n2 weekend) or (kw: shift* n2 twilight)) or ((kw: hour* n shift) or (kw: hour* n shifts)) or ((kw: shift* n2 continental) or (kw: shift* n2 continuous) or (kw: shift* n2 turnaround) or (kw: shift* n2 split)) or ((kw: shift* n2 nonstandard) or (kw: shift* n2 non-standard)) or ((kw: nonstandard n2 working) or (kw: non-standard n2 working) or (kw: unsocial n2 working) or (kw: antisocial n2 working) or (kw: anti-social n2 working)) or ((kw: antisocial n2 working) or (kw: anti-social n2 working) or (kw: antisocial n2 work) or (kw: anti-social n2 work) or (kw: antisocial n2 works) or (kw: anti-social n2 works)) or ((kw: unsocia* n2 shift*) or (kw: antisocia* n2 shift*) or (kw: anti-socia* n2 shift*)) or ((kw: irregular* n2 shift*) or (kw: irregular n2 work) or (kw: irregular n2 working)) or ((kw: compressed n work) or (kw: compressed n working)) or ((kw: long n work n hour*) or (kw: long n working n hour*)) or ((kw: extended n duty n hour*) or (kw: extended n work n hours*)) or (kw: overtime or kw: flextime or (kw: flex n time) or kw: flexitime or (kw: flexi n time)) or ((kw: flex* n work) or (kw: flex* n working)) and ((kw: legislat* or kw: law or kw: laws) or (kw: working n time n directive) or ((kw: eu n3 work) or (kw: eu n3 working) or (kw: europe n3 work) or (kw: europe n3 working)) or ((kw: european n commission) or (kw: european n union)) or ((kw: bright n light) or (kw: bright n lights) or (kw: bright n lighting)) or (kw: nap or kw: naps or kw: napped or kw: napping or kw: clockwise) or (kw: reorganis* or kw: reorganiz* or kw: re-organis* or kw: re-organiz*) or (kw: restructur* or kw: re-structur* or kw: entrain* or kw: re-entrain*) or (kw: countermeasure* or kw: surveillance or kw: ergonomic*) or (kw: reschedul* or kw: re-schedul* or kw: redesign* or kw: re-design*) or ((kw: self n help) or kw: selfhelp or (kw: self n schedul*) or (kw: self n roster*)) or (kw: coping or kw: cope* or kw: counsel* or kw: empower*) or (kw: circadian or kw: phototherap* or (kw: light n treatment) or (kw: light n therap*) or kw: melatonin*) or (kw: chang* or kw: modif* or kw: design* or kw: intervention* or kw: impact* or kw: alter* or kw: adapt* or kw: measure* or kw: manag* or kw: strateg* or kw: reduc* or kw: increas* or kw: particip* or kw: educat* or kw: train* or kw: program*))).

Management Contents (1983-2005/Nov 22) (Dialog)

Searched 24/11/05.

317 records retrieved

- S1 SHIFTWORK?(TI,AB
- S2 NIGHTWORK?(TI,AB
- S3 ((SHIFT OR SHIFTS)(2N)(WORK? OR NIGHT?))/TI,AB
- S4 (NIGHT?(2N)WORK?)/TI,AB
- S5 NIGHTSHIFT?(TI,AB
- S6 ((SHIFT OR SHIFTS)(2N)(ROTA? OR SYSTEM OR SYSTEMS OR SCHEDULE? OR ROSTER?))/TI,AB
- S7 ((SHIFT OR SHIFTS)(2N)(EXTEND? OR PATTERN? OR CYCLE?))/TI,AB
- S8 ((SHIFT OR SHIFTS)(2N)(EVENING OR LATE OR EARLY OR WEEKEND OR TWILIGHT))/TI,AB
- S9 ((HOUR?(W)SHIFT) OR (HOUR?(W)SHIFTS))/TI,AB
- S10 ((SHIFT OR SHIFTS)(2N)(CONTINENTAL OR CONTINUOUS OR TURNAROUND OR SPLIT))/TI,AB

S11 ((NONSTANDARD OR NON-STANDARD)(2N)(WORK? OR SHIFT OR SHIFTS))/TI,AB
S12 ((UNSOCIA? OR ANTISOCIA? OR ANTI-SOCIA?)(2N)(WORK? OR SHIFT OR SHIFTS))/TI,AB
S13 (IRREGULAR?(2N)(WORK? OR SHIFT OR SHIFTS))/TI,AB
S14 COMPRESSED(W)WORK?/TI,AB
S15 LONG(W)WORK?(W)HOUR?/TI,AB
S16 ((EXTEND?(W)DUTY(W)HOUR?) OR (EXTEND?(W)DUTIES(W)HOUR?) OR (EXTEND?(W)WORK?(W)HOUR?))/TI,AB
S17 OVERTIME/TI,AB
S18 (FLEXTIME OR FLEX TIME OR FLEXITIME OR FLEXI TIME)/TI,AB
S19 FLEX?(W)WORK?/TI,AB
S20 S1:S19
S21 LEGISLAT?/TI,AB
S22 (LAW OR LAWS)/TI,AB
S23 WORK?(W)TIME(W)DIRECTIVE/TI,AB
S24 ((EU OR EUROPE?)(3N)WORK?)/TI,AB
S25 ((EUROPEAN(W)COMMISSION) OR (EUROPEAN(W)UNION))/TI,AB
S26 BRIGHT(W)LIGHT?/TI,AB
S27 (NAP OR NAPS OR NAPPED OR NAPPING)/TI,AB
S28 CLOCKWISE/TI,AB
S29 (REORGANIS? OR REORGANIZ? OR RE(W)ORGANIS? OR RE(W)ORGANIZ?)/TI,AB
S30 (RESTRUCTUR? OR RE(W)STRUCTUR?)/TI,AB
S31 (ENTRAIN? OR RE(W)ENTRAIN?)/TI,AB
S32 (COUNTERMEASURE? OR SURVEILLANCE)/TI,AB
S33 (RESCHEDUL? OR RE(W)SCHEDUL? OR REDESIGN? OR RE(W)DESIGN?)/TI,AB
S34 ERGONOMIC?/TI,AB
S35 (SELF(W)HELP OR SELFHELP)/TI,AB
S36 (SELF(W)SCHEDUL? OR SELF(W)ROSTER?)/TI,AB
S37 (COPING OR COPE?)/TI,AB
S38 COUNSEL?/TI,AB
S39 EMPOWER?/TI,AB
S40 CIRCADIAN/TI,AB
S41 PHOTOTHERAP?/TI,AB
S42 (LIGHT(W)TREATMENT OR LIGHT(W)THERAP?)/TI,AB
S43 MELATONIN?/TI,AB
S44 ((STRUCTUR? OR ORGANIS? OR ORGANIZ? OR MANAGEMENT OR MANAGERIAL)(3N)(CHANG? OR MODIF? OR DESIGN? OR INTERVENTION?))/TI,AB
S45 ((STRUCTUR? OR ORGANIS? OR ORGANIZ? OR MANAGEMENT OR MANAGERIAL)(3N)(IMPACT? OR ALTER? OR ADAPT? OR MEASURE? OR STRATEG?))/TI,AB
S46 ((STRUCTUR? OR ORGANIS? OR ORGANIZ? OR MANAGEMENT OR MANAGERIAL)(3N)(REDUC? OR INCREAS? OR PARTICIP? OR EDUCAT? OR TRAIN? OR PROGRAM?))/TI,AB
S47 ((SHIFT? OR WORK? OR HOUR?)(3N)(CHANG? OR MODIF? OR DESIGN? OR INTERVENTION?))/TI,AB
S48 ((SHIFT? OR WORK? OR HOUR?)(3N)(IMPACT? OR ALTER? OR ADAPT? OR MEASURE? OR MANAG? OR STRATEG?))/TI,AB
S49 ((SHIFT? OR WORK? OR HOUR?)(3N)(REDUC? OR INCREAS? OR PARTICIP? OR EDUCAT? OR TRAIN? OR PROGRAM?))/TI,AB
S50 S21:S49
S51 S20 AND S50

For all of the following databases/websites, the unsophisticated search interfaces made it impractical or impossible to combine lines of search terminology, therefore the sole concept of shiftwork was searched.

Index to Theses (1716-9/11/05) (<http://www.theses.com/>)

Searched 28/11/05.

29 records retrieved

[Results scanned as database does not allow automatic download of material].

1. ti contains (shiftwork* or nightwork* or nightshift* or compressed work* or long work* hour* or overtime)
2. ti contains (flextime or flex time or flexitime or flexi time or hour* shift or hour* shifts)
3. ti contains (flex* work* or shift work* or shifts work* or night* shift or night shifts or night* work*)
4. ti contains (rota* shift* or shift* system or shift* systems or shift* schedule* or shift* roster* or extend* shift*)
5. ti contains (shift* pattern* or shift* cycle* or evening shift* or late shift* or early shift* or weekend shift*)
6. ti contains (twilight shift* or continental shift* or continuous shift* or shift* turnaround or split shift* or nonstandard work*)
7. ti contains (nonstandard shift* or non-standard work* or non-standard shift* or unsocia* work* or unsocia* shift* or antisocia* work*)
8. ti contains (antisocia* shift* or anti-socia* work* or anti-socia* shift*)
9. ti contains (irregular* work* or irregular shift* or extend* duty hour* or extend* duties hour* or extend* work* hour*)

Dissertation Abstracts (1861-to date) (UMI Proquest)

Searched 28/11/05.

194 records retrieved

1. TI(irregular? work?) or TI(irregular shift?) or TI(extend? duty hour?) or TI(extend? duties hour?) or TI(extend? work? hour?)
2. TI(antisocia? shift?) or TI(anti-socia? work?) or TI(anti-socia? shift?)
3. TI(nonstandard shift?) or TI(non-standard work?) or TI(non-standard shift?) or TI(unsocia? work?) or TI(unsocia? shift?) or TI(antisocia? work?)
4. TI(twilight shift?) or TI(continental shift?) or TI(continuous shift?) or TI(shift? turnaround) or TI(split shift?) or TI(nonstandard work?)
5. TI(shift? pattern?) or TI(shift? cycle?) or TI(evening shift?) or TI(late shift?) or TI(early shift?) or TI(weekend shift?)
6. TI(rota? shift?) or TI(shift? system) or TI(shift? systems) or TI(shift? schedule?) or TI(shift? roster?) or TI(extend? shift?)
7. TI(flex? work?) or TI(shift work?) or TI(shifts work?) or TI(night? shift) or TI(night shifts) or TI(night? work?)
8. TI(flextime) or TI(flex time) or TI(flexitime) or TI(flexi time) or TI(hour? shift) or TI(hour? shifts)
9. TI(shiftwork?) or TI(nightwork?) or TI(nightshift?) or TI(compressed work?) or TI(long work? hour?) or TI(overtime)

JSTOR (last updated 17/11/05) (JSTOR)

Searched 23/11/05.

81 records retrieved

(ti:(shiftwork??? OR nightwork??? OR nightshift??? OR "shift work" OR "shift working" OR "shift worker" OR "shift workers" OR "night shift" OR "night shifts" OR "night work" OR "night working" OR "night worker" OR "night workers" OR "rotating shift" OR "rotating shifts" OR "shift system" OR "shift systems" OR "shifts system" OR "shifts systems" OR "shift schedule" OR "shifts schedule" OR "shift schedules" OR "shifts schedules" OR "shift scheduling" OR "shifts scheduling" OR "shift roster" OR "shifts roster" OR "shift rosters" OR "shifts rosters" OR "shift rostering" OR "shifts rostering" OR "extended shift" OR "extended shifts" OR "shift pattern" OR "shift patterns" OR "shifts pattern" OR "shifts patterns" OR "shift cycle" OR "shift cycles" OR "shifts cycle" OR "shifts cycles" OR "evening shift" OR "evening shifts" OR "late shift" OR "late shifts" OR "early shift" OR "early shifts" OR "weekend shift" OR "weekend shifts" OR "twilight shift" OR "twilight shifts" OR "continental shift" OR "continental shifts" OR "continuous shift" OR "continuous shifts" OR "turnaround shift" OR "turnaround shifts" OR "split shift" OR "split shifts" OR "nonstandard shift" OR "nonstandard shifts" OR "non standard shift" OR "non standard shifts" OR "unsociable shift" OR "unsociable shifts" OR "antisocial shift" OR "antisocial shifts" OR "anti social shift" OR "anti social shifts" OR "irregular shift" OR "irregular shifts") OR ab:(shiftwork??? OR nightwork??? OR nightshift??? OR "shift work" OR "shift working" OR "shift worker" OR "shift workers" OR "night shift" OR "night shifts" OR "night work" OR "night working" OR "night worker" OR "night workers" OR "rotating shift" OR "rotating shifts" OR "shift system" OR "shift systems" OR "shifts system" OR "shifts systems" OR "shift schedule" OR "shifts schedule" OR "shift schedules" OR "shifts schedules" OR "shift scheduling" OR "shifts scheduling" OR "shift roster" OR "shifts roster" OR "shift rosters" OR "shifts rosters" OR "shift rostering" OR "shifts rostering" OR "extended shift" OR "extended shifts" OR "shift pattern" OR "shift patterns" OR "shifts pattern" OR "shifts patterns" OR "shift cycle" OR "shift cycles" OR "shifts cycle" OR "shifts cycles" OR "evening shift" OR "evening shifts" OR "late shift" OR "late shifts" OR "early shift" OR "early shifts" OR "weekend shift" OR "weekend shifts" OR "twilight shift" OR "twilight shifts" OR "continental shift" OR "continental shifts" OR "continuous shift" OR "continuous shifts" OR "turnaround shift" OR "turnaround shifts" OR "split shift" OR "split shifts" OR "nonstandard shift" OR "nonstandard shifts" OR "non standard shift" OR "non standard shifts" OR "unsociable shift" OR "unsociable shifts" OR "antisocial shift" OR "antisocial shifts" OR "anti social shift" OR "anti social shifts" OR "irregular shift" OR "irregular shifts")) AND ty:FLA

CORDIS (Community Research & Development Information Service)

<http://www.cordis.lu/en/home.html>

Searched 28/11/05.

2 records retrieved

[Results scanned as database does not allow automatic download of material].

1. shiftwork* or nightwork* or nightshift* or overtime or flextime or flexitime
2. "night work" or "night working" or "night worker" or "night workers" or "working nights"
3. "long work hours" or "long working hours" or "compressed work" or "compressed working"
4. "extended duty hours" or "extended work hours" or "irregular work" or "irregular working" or "nonstandard working" or "non standard working"
5. "shift work" or "shift working" or "shift worker" or "shift workers" or "working shifts"
6. "night shift" or "night shifts" or "rotating shift" or "rotating shifts"
7. "shift system" or "shift systems" or "shifts system" or "shifts systems" or "shift schedule" or "shifts schedule" or "shift schedules" or "shifts schedules" or "shift scheduling" or "shifts scheduling"

8. "shift roster" or "shifts roster" or "shift rosters" or "shifts rosters" or "shift rostering" or "shifts rostering" or "extended shift" or "extended shifts"
9. "shift pattern" or "shift patterns" or "shifts pattern" or "shifts patterns" or "shift cycle" or "shift cycles" or "shifts cycle" or "shifts cycles"
10. "evening shift" or "evening shifts" or "late shift" or "late shifts" or "early shift" or "early shifts" or "weekend shift" or "weekend shifts"
11. "twilight shift" or "twilight shifts" or "hour shift" or "hour shifts" or "hours shift" or "hours shifts"
12. "continental shift" or "continental shifts" or "continuous shift" or "continuous shifts" or "turnaround shift" or "turnaround shifts" or "split shift" or "split shifts"
13. "nonstandard shift" or "nonstandard shifts" or "non standard shift" or "non standard shifts" or "unsociable shift" or "unsociable shifts" or "antisocial shift" or "antisocial shifts" or "anti social shift" or "anti social shifts"
14. "irregular shift" or "irregular shifts" or "flex time" or "flexi time"

ESRC (Economic & Social Research Council)

(<http://www.regard.ac.uk/ESRCInfoCentre/index.aspx>)

Searched 29/11/05.

8 records retrieved

[Results scanned as website does not allow automatic download of material].

1. shiftwork or shiftworker or shiftworkers or shiftworking or nightwork or nightworker or nightworkers or nightworking or nightshift or nightshifts or overtime or flexitime or flexitime
2. "night work" or "night working" or "night worker" or "night workers" or "working nights"
3. "long work hours" or "long working hours" or "compressed work" or "compressed working"
4. "extended duty hours" or "extended work hours" or "irregular work" or "irregular working" or "nonstandard working" or "non standard working"
5. "shift work" or "shift working" or "shift worker" or "shift workers" or "working shifts"
6. "night shift" or "night shifts" or "rotating shift" or "rotating shifts"
7. "shift system" or "shift systems" or "shifts system" or "shifts systems" or "shift schedule" or "shifts schedule" or "shift schedules" or "shifts schedules" or "shift scheduling" or "shifts scheduling"
8. "shift roster" or "shifts roster" or "shift rosters" or "shifts rosters" or "shift rostering" or "shifts rostering" or "extended shift" or "extended shifts"
9. "shift pattern" or "shift patterns" or "shifts pattern" or "shifts patterns" or "shift cycle" or "shift cycles" or "shifts cycle" or "shifts cycles"
10. "evening shift" or "evening shifts" or "late shift" or "late shifts" or "early shift" or "early shifts" or "weekend shift" or "weekend shifts"
11. "twilight shift" or "twilight shifts" or "hour shift" or "hour shifts" or "hours shift" or "hours shifts" or "continental shift" or "continental shifts" or "continuous shift" or "continuous shifts" or "turnaround shift" or "turnaround shifts" or "split shift" or "split shifts"
12. "nonstandard shift" or "nonstandard shifts" or "non standard shift" or "non standard shifts" or "unsociable shift" or "unsociable shifts" or "antisocial shift" or "antisocial shifts" or "anti social shift" or "anti social shifts" or "irregular shift" or "irregular shifts" or "flex time" or "flexi time"

EconPapers (<http://econpapers.repec.org/>)

Searched 29/11/05.

6 records retrieved

[Results scanned as database does not allow automatic download of material].

1. shiftwork* or nightwork* or nightshift*
2. overtime or flextime or flexitime
3. "night work" or "night working" or "night worker" or "night workers" or "working nights"
4. "long work hours" or "long working hours" or "compressed work" or "compressed working"
5. "extended duty hours" or "extended work hours" or "irregular work" or "irregular working" or "nonstandard working" or "non standard working"
6. "shift work" or "shift working" or "shift worker" or "shift workers" or "working shifts"
7. "night shift" or "night shifts" or "rotating shift" or "rotating shifts"
8. "shift system" or "shift systems" or "shifts system" or "shifts systems" or "shift schedule" or "shifts schedule" or "shift schedules" or "shifts schedules" or "shift scheduling" or "shifts scheduling"
9. "shift roster" or "shifts roster" or "shift rosters" or "shifts rosters" or "shift rostering" or "shifts rostering" or "extended shift" or "extended shifts"
10. "shift pattern" or "shift patterns" or "shifts pattern" or "shifts patterns" or "shift cycle" or "shift cycles" or "shifts cycle" or "shifts cycles"
11. "evening shift" or "evening shifts" or "late shift" or "late shifts" or "early shift" or "early shifts" or "weekend shift" or "weekend shifts"
12. "twilight shift" or "twilight shifts" or "hour shift" or "hour shifts" or "hours shift" or "hours shifts"
13. "continental shift" or "continental shifts" or "continuous shift" or "continuous shifts" or "turnaround shift" or "turnaround shifts" or "split shift" or "split shifts"
14. "nonstandard shift" or "nonstandard shifts" or "non standard shift" or "non standard shifts" or "unsociable shift" or "unsociable shifts" or "antisocial shift" or "antisocial shifts" or "anti social shift" or "anti social shifts"
15. "irregular shift" or "irregular shifts" or "flex time" or "flexi time"

NTIS (National Technical Information Service)

(<http://www.ntis.gov/index.asp?loc=2-0-0>)

Searched 29/11/05.

35 records retrieved

[Results scanned as database does not allow automatic download of material].

1. shiftwork or shiftworker or shiftworkers or shiftworking or nightwork or nightworker or nightworkers or nightworking or nightshift or nightshifts
2. overtime or flextime or flexitime
3. "night work" or "night working" or "night worker" or "night workers" or "working nights"
4. "long work hours" or "long working hours" or "compressed work" or "compressed working"
5. "extended duty hours" or "extended work hours" or "irregular work" or "irregular working" or "nonstandard working" or "non standard working"
6. "shift work" or "shift working" or "shift worker" or "shift workers" or "working shifts"
7. "night shift" or "night shifts" or "rotating shift" or "rotating shifts"
8. "shift system" or "shift systems" or "shifts system" or "shifts systems" or "shift schedule" or "shifts schedule" or "shift schedules" or "shifts schedules" or "shift scheduling" or "shifts scheduling"
9. "shift roster" or "shifts roster" or "shift rosters" or "shifts rosters" or "shift rostering" or "shifts rostering" or "extended shift" or "extended shifts"
10. "shift pattern" or "shift patterns" or "shifts pattern" or "shifts patterns" or "shift cycle" or "shift cycles" or "shifts cycle" or "shifts cycles"
11. "evening shift" or "evening shifts" or "late shift" or "late shifts" or "early shift" or "early shifts" or "weekend shift" or "weekend shifts"

12. "twilight shift" or "twilight shifts" or "hour shift" or "hour shifts" or "hours shift" or "hours shifts" or "continental shift" or "continental shifts" or "continuous shift" or "continuous shifts" or "turnaround shift" or "turnaround shifts" or "split shift" or "split shifts"
13. "nonstandard shift" or "nonstandard shifts" or "non standard shift" or "non standard shifts" or "unsociable shift" or "unsociable shifts" or "antisocial shift" or "antisocial shifts" or "anti social shift" or "anti social shifts" or "irregular shift" or "irregular shifts" or "flex time" or "flexi time"

Harvard Business Review

<http://harvardbusinessonline.hbsp.harvard.edu/hbrsa/en/archive/archive.jhtml>

Searched 02/12/05.

2 records retrieved

[Results scanned as website does not allow automatic download of material].

shiftwork
 shiftworker
 shiftworkers
 shiftworking
 nightwork
 nightworker
 nightworkers
 nightworking
 nightshift
 nightshifts
 overtime
 flextime
 flexitime
 "night work" or "night working"
 "night worker" or "night workers"
 "working nights" or "long work hours"
 "long working hours" or "compressed work"
 "compressed working" or "extended duty hours"
 "extended work hours" or "irregular work"
 "irregular working" or "nonstandard working"
 "non standard working" or "shift work"
 "shift working" or "shift worker"
 "shift workers" or "working shifts"
 "night shift" or "night shifts"
 "rotating shift" or "rotating shifts"
 "shift system" or "shift systems"
 "shifts system" or "shifts systems"
 "shift schedule" or "shifts schedule"
 "shift schedules" or "shifts schedules"
 "shift scheduling" or "shifts scheduling"
 "shift roster" or "shifts roster"
 "shift rosters" or "shifts rosters"
 "shift rostering" or "shifts rostering"
 "extended shift" or "extended shifts"
 "shift patterns" or "shifts pattern"
 "shifts patterns" or "shift cycle"
 "shift cycles" or "shifts cycle"
 "shifts cycles" or "shift pattern"
 "evening shift" or "evening shifts"
 "late shift" or "late shifts"

"early shift" or "early shifts"
"weekend shift" or "weekend shifts"
"twilight shift" or "twilight shifts"
"hour shift" or "hour shifts"
"hours shift" or "hours shifts"
"continental shift" or "continental shifts"
"continuous shift" or "continuous shifts"
"turnaround shift" or "turnaround shifts"
"split shift" or "split shifts"
"nonstandard shift" or "nonstandard shifts"
"non standard shift" or "non standard shifts"
"unsociable shift" or "unsociable shifts"
"antisocial shift" or "antisocial shifts"
"anti social shift" or "anti social shifts"
"irregular shift" or "irregular shifts"
"flex time" or "flexi time"

**European Commission Libraries Catalogue (<http://europa.eu.int/eclas/>)
Searched 02/12/05.
259 records retrieved**

shiftwork* nightwork* nightshift* overtime flexitime flexitime
night work*
working nights
long work* hours
compressed work*
extended duty hours
extended work hours
irregular work*
nonstandard working
non standard working
shift work*
working shifts
night shift
night shifts
rotating shift
rotating shifts
shift* system
shift* systems
shift* schedul*
shift* roster*
extended shift
extended shifts
shift pattern*
shifts pattern*
shift* cycle*
evening shift*
late shift*
early shift*
weekend shift*
twilight shift*
hour shift
hours shift
hourly shift
continental shift*

continuous shift*
turnaround shift*
split shift*
nonstandard shift*
non standard shift*
unsociable shift*
antisocial shift*
anti social shift*
irregular shift*
flex time
flexi time

Labordoc (<http://labordoc.ilo.org/>)

Searched 02/12/05.

493 records retrieved

[Most terms were searched in keyword, but some were searched in titles only as yield was high and false using keywords.]

shiftwork?
nightwork?
nightshift?
overtime [titles only]
flextime
flexitime
"flex time"
"flexi time"
"night work" [titles only]
"night working"
"night worker"
"night workers"
"working nights"
"long work hours"
"long working hours"
"compressed work"
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"extended work hours"
"irregular work"
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"nonstandard working"
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"shift work" [titles only]
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"shifts patterns"
"shift cycle"
"shift cycles"
"shifts cycle"
"shifts cycles"
"shift pattern"
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"evening shifts"
"late shift"
"late shifts"
"early shift"
"early shifts"
"weekend shift"
"weekend shifts"
"twilight shift"
"twilight shifts"
"hour shift"
"hour shifts"
"hours shift"
"hours shifts"
"continental shift"
"continental shifts"
"continuous shift"
"continuous shifts"
"turnaround shift"
"turnaround shifts"
"split shift"
"split shifts"
"nonstandard shift"
"nonstandard shifts"
"non standard shift"
"non standard shifts"
"unsociable shift"
"unsociable shifts"
"antisocial shift"
"antisocial shifts"
"anti social shift"
"anti social shifts"
"irregular shift"
"irregular shifts"

APPENDIX 2: Example Critical Appraisal Form

Reviewer's initials:

Bibliographical details

Author	
Year	
Title	

Critical Appraisal of Study Design

Study design description:

Methods Appraisal	Yes/no/NS
Is the study prospective?	
Is the study based on a representative sample selected from a relevant population? (include random samples, adequately justified purposive sampling, or 100% samples as 'representative')	
Does the study use an appropriate control group? (e.g. random allocation or appropriately matched control)	
Is the baseline response equal or greater than 60% of initial sample?	
Is (a) the follow-up rate in a cohort study equal to or greater than 80% of the baseline response, or (b) is each follow-up survey in a repeat cross-sectional study equal to or greater than 60% of the follow-up sample?	
Are the effects of non-responses and/or drop-outs explored?	
Are the authors conclusions' substantiated by the data in their results (note that if the results contain insufficient data to verify the authors conclusion, the answer is 'no')?	
Are the effects of potentially important confounding factors explored?	
Were all members of the study population (or intervention group) exposed to the intervention?	
Does the study use statistical tests appropriate to the type of data?	

Intervention & Implementation	Yes/no/NS
Has the intervention been explicitly designed to improve employee health or the psychosocial work environment? Answer yes/no/, and write 'health' or 'psychosocial' as appropriate.	-
Was the intervention motivated by economic or other managerial interests? Answer yes/no/, and write 'economic' or 'managerial' as appropriate.	-
Were employees in favour/supportive of the intervention (eg. do authors comment on employee's views of intervention? Did employee's volunteer for it? Union support, etc)?	-
Were on-site managers/supervisors in favour/supportive of the intervention (e.g. do authors comment on managerial views of intervention? Did they help initiate it? etc)?	-
Does study provide any useful contextual information relevant to implementation of the intervention (e.g. political, economic or managerial?)	-
Does study establish whether those implementing the intervention had appropriate experience? (eg. had the implementers conducted similar interventions before; or if managers/employees were involved, were they appropriately trained for new roles?)	-
Is there a description of the planning and consultation process?	-
Is there a description of the collaborations involved in delivery?	-
Does study describe how the target population were identified and recruited for the intervention, or why the management decided to make the organisational change?	-
Does study give information about the resources required in implementing the intervention (eg. time, money, people, and equipment, required for the intervention)?	-

APPENDIX 3: Example Data extraction Form

Reviewer's initials:

Bibliographical details

Author	
Year	
Title	
Secondary publications	

Study details

		Page no.
City/region/Country		
Workplace setting (e.g. hospital)		
Type of employee (e.g. professional, nurse)		
Details about sample (e.g. gender, grade, etc).		
Shiftwork system(s)		
Intervention (description)		
Background to intervention (why was it implemented?)		
Length of intervention		

Method and Design

		Page no.
Design (e.g. prospective cohort)		
Total Population (number)		
Baseline sample size (number for control and intervention groups separately)		
Method of sampling (random? stratified, etc)		
Baseline response rate (% or number)		
Time between intervention and follow-ups		
Follow-up response as % of baseline (calculate if necessary)		
Final sample size		
Is potential confounding from attrition/non-response explored? Any adjustments made?		
Other potential confounding factors (eg. concurrent interventions, not all intervention group exposed?)		
CONTROLLED STUDIES ONLY		
Control group selection (e.g. NS or give method of randomisation or matching)		
Demographic confounding between intervention and control groups explored? Any adjustment made?		
Contamination between intervention and control group?		

Outcomes

		Page no.
List any specific physical health measures used		
List any specific mental health measures used (e.g. GHQ12)		
List any general health measures used (include absenteeism, GP visits)		
List any measures of health behaviour (eg. diet, smoking, drinking, exercise etc).		
List any psychosocial measures (DCS, effort-reward, work/life balance)		
List any economic and work-related measures (eg. job satisfaction, productivity)		

Results

Include p-values, se, sd, means, F ratios, CIs etc. Calculate if necessary. For controlled studies compare to control and give intervention group over time results.

		Page no.
Briefly summarise the key effects of the intervention on the health measures (and scales used)		
Briefly summarise the key effects of the intervention on the psychosocial measures (and scales used)		
Briefly summarise the key effects of the intervention on the economic measures (and scales used)		

APPENDIX 4: Summary results tables

Key for methods appraisal

- 1= prospective;
- 2= representative sample;
- 3= appropriate comparison group;
- 4= baseline response >60%;
- 5= follow-up >80% in cohort, >60% in cross-section;
- 6= adjustment for non-response and drop-out;
- 7=conclusions substantiated by data;
- 8=adjustment for confounders;
- 9= all intervention group exposed, non-contaminated comparison;
- 10= appropriate statistical tests.

Summary table 1: Compressed work week - prospective cohort studies with a control group

Study	Design & Methods Appraisal ^A	Setting & Participants	Background	Implementation	Health/Wellbeing/Economic Outcomes
Barton-Cunningham 1981, 1982 [39, 40]	5 month and 6 month follow-ups Final sample: n=30 (17 intervention, 13 control) Methods: 1 4 7 9	Police Force, Canada. Police Officers, majority men.	Five 8hr shifts, two days off to Four 10hr shifts, three days off Introduced as result of a request from employees who had heard about other police forces using such systems.	Few reported details on effectiveness of implementation.	<p>↑ = improvement ↓ = worsening ↔ = little change</p> <p>Sporting activities Absenteeism</p> <p>Time spent on domestic chores Time spent on family matters Time spent with spouse Time spent socialising with friends</p> <p>Job satisfaction</p>
Barton-Cunningham 1989 [41]	Unspecified follow-up Final sample: n=85 (68 intervention, 17 control) Methods: 1 7 9 10	Mine, Canada. Mine operatives and plant operators, young married males, age<39.	Five 8hr shifts, two days off to Four 12hr shifts, four days off. Introduced as result of an agreement amongst employees, union and managers who had heard about such systems and wanted to try it for differing reasons (more leisure time in the case of employees, more productivity for the managers).	Few reported details on effectiveness of implementation.	<p>↑ ↑ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔</p> <p>Absence Accidents Sleep problems Tiredness</p> <p>Tensions due to job Tensions due to people Tensions due to job characteristics Family satisfaction</p> <p>Satisfaction with work</p>
Totterdell & Smith 1992 [42]	6 month follow-up Final sample: n=70 (40 intervention, 30 control) Methods: 1 2 3 5 7 9 10	Police service, UK. Police Officers.	Seven 8hr shifts, two days off to 'Ottawa' system (10hr days and 8hr nights). Intervention had been successful in reducing sickness absence at other sites.	Few reported details on effectiveness of implementation.	<p>↑ ↑*</p> <p>GHQ Lack of sleep Fatigue Headaches Stomach aches Sleep duration Stress Feeling unwell Irregular meals Sleep quality</p> <p>Insufficient time for family Insufficient time for friends Insufficient time for social life</p>

Study	Design & Methods Appraisal ^A	Setting & Participants	Background	Implementation	Health/Wellbeing/Economic Outcomes
Lowden et al 1998 [43]	10 month follow-up Final sample: n=46 (32 intervention, 14 control) Methods: 1 2 4 5 7 9 10	Chemical plant, Sweden. Plant operators, mainly men.	Five 8hr shifts, three days off to two or three 12hr shifts, up to five days off Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	<p>↑ = improvement ↓ = worsening ↔ = little change</p> <p>Personal life disrupted Planning social life difficult Domestic arrangements difficult Poor relations with family Not enough free time</p> <p>Effective at work Fatigue affects work</p> <p>Easy to fall asleep Rested when wake up Sleep quality Fatigue Sufficient sleep General health</p> <p>Time for social/family activities Satisfaction with hours</p>
Smith et al 1998 [44]	6 month follow-up Final sample: n=45 (27 intervention, 18 control) Methods: 1 2 4 7 8 9 10	Police service, UK. Police Officers, mainly men.	Five or seven 8hr shifts, two or three days off to site A: Flexible starts with four 12hr shifts, then four days off or site B: Rigid starts with four 12hr shifts, then four days off. Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	<p>↑↑</p> <p>Standard Shiftwork Index Sleep duration (day) Sleep quality (rest) Standard Shiftwork Index Chronic fatigue Standard Shiftwork Index Physical health Standard Shiftwork Index GHQ-12</p> <p>Workload Standard Shiftwork Index Work pace control Standard Shiftwork Index Social/domestic interference Standard Shiftwork Index</p>

* There were significant differences between intervention and control groups at baseline.

† Effect disappeared when shift work experience was controlled for.

Summary table 2: Compressed work week – other prospective studies (grouped by study design)

Study	Design & Methods Appraisal	Setting & Participants	Background	Implementation	Health/Wellbeing/Economic Outcomes
PROSPECTIVE COHORT STUDIES					
Stinson & Hazlett, 1975 [45]	1 month follow-up Final sample: n=23 Methods: 1 2 4 7 9 10	Hospital, Canada. Nurses, mainly female.	Five 8hr shifts, two days off to Three/four 12hr shifts, four/three days off Few reported details on background to intervention.	Few reported details on effectiveness of implementation. At the end of the pilot period, 79% of employees expressed a preference for the new system.	Tired on the job Opportunity to use skills Time available for recreation No confusion in work roles Not feeling overloaded with work Opportunity to make decisions <i>Personal Health Survey:</i> Health complaints Cardiovascular complaints Anxiety Anger-frustration <i>Nurses perception questionnaire:</i> Fatigue Felt more rested Absence Accidents and injuries <i>Work environment scale:</i> Managerial control Staff innovation Staff autonomy Role clarity <i>Minnesota Satisfaction Questionnaire:</i> Job satisfaction Turnover Incidents and errors
Eaton & Gottselig, 1980 [46]	6 month follow-up Final sample: n=24 Methods: 1 2 7 9 10	Hospital, Canada. Nurses, mainly female.	8hr shifts to 12hr shifts New system requested by staff.	Few reported details on effectiveness of implementation.	↓ ↓ ↓ ↓ ↓ ↓ ↓ ↑ ↔ ↔ ↓ ↑ ↑ ↑ ↓ ↔ ↓ ↓ ↔

Peacock et al, 1983 [47]	6 month follow-up. Final sample: n=75 Methods: 1 7 9 10	Police Force, Canada. Police Officers.	Eight 8hr shifts, four days off to Five 12hr shifts, three days off Few reported details on background to intervention.	Few reported details on effectiveness of implementation. Employees did vote to keep the new system though.	Sleep duration Alertness	↑ ↔
Rosa et al, 1989; Lewis & Swaim, 1986; Rosa, 1991 [48-50]	7 month follow up Final sample: n=50 Methods: 1 5 9 10	Processing plant, USA. Control room operators, mainly male aged 25-34.	Five/seven 8hr shifts, two/four days off to Three/four 12hr shifts, three/six days off Few reported details on background to intervention.	Few reported details on effectiveness of implementation. 80% of employees voted to keep the new system because they valued the extra days off.	Gastro-intestinal state (night) Gastro-intestinal state (day) Exercise Napping after shift (night) Napping after shift (day) Stress Total sleep time Number of awakenings Sleep depth Sleep quality Sleep latency Adjust personal routine for work Missed social events	↑ ↔ ↓ ↑ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↓ ↔
Jansen & Muij, 1990 [51]	6 month follow up Final sample: n=87 Methods: 1 2 7 9 10	Confectionary Factory, Netherlands. Packaging Department workers, all female, 46 full-time, 41 part-time.	Five 8hr shifts, two days off to Three 12hr shifts, four days off Intervention introduced by management to accommodate the fact that the working week was reduced from 40 to 36hrs whilst operating time was simultaneously increased from 40 to 45hrs.	Few reported details on effectiveness of implementation.	Fatigue Gastro-intestinal complaints Time spent with family Satisfaction with leisure time	↔ ↔ ↑ ↔
Slota & Balas-Stevens, 1990 [52]	3 month follow up Final sample: n=36 Methods: 1 2 9 10	Hospital, USA. Nurses, all female.	Five 8hr shifts, two days off to Three 12.5hr shifts, four days off Intervention initiated by staff to increase job motivation.	Employees, Union and managers were supportive of the intervention. Staff input central to the planning and consultation process, key delivery collaborations between staff, union and managers aided implementation. Staff voted to maintain the new system.	Absence Concern about scheduling of vacation time Ability to request time off Incidents and errors Personal productivity	↑ ↔ ↔ ↔ ↔

Pierce & Dunham, 1992 [53]	12 month follow up Final sample: n=50 Methods: 1 2 4 7 9 10	Police Force, USA. Police officers, mainly male.	Seven/ten 8hr shifts, two/three days off to Four 12hr shifts, four days off Intervention initiated by managers to ensure that they could maintain 24/7 service in the summer whilst also accommodating vacation requests.	Few reported details on effectiveness of implementation. Employees, Union and managers were supportive of the intervention.	Physiological distress Fatigue Stress Schedule interference with personal activities Satisfaction with leisure time Life satisfaction Satisfaction with organisational association Satisfaction with workload Job satisfaction Organisational effectiveness Performance Depression Absence Accidents General life satisfaction Conflict between work and non-work time Relations with co-workers and supervisors Social/community involvement Planning activities with family Job satisfaction	↑ ↑ ↑ ↑ ↑ ↑ ↔ ↔ ↑ ↑ ↔ ↔ ↑ ↔
Williams, 1992 [54]	6 month follow up Final sample: n=131 Methods: 1 2 4 5 6 7 9 10	Chemical Plant, USA. Operators, mainly white males.	Six/seven 8hr shifts, two/four days off to Three/four 12hr shifts, two to seven days off Intervention initiated by staff to improve their work/life balance. 90% of staff were dissatisfied with the old system and other local factories had started using 12hr shifts.	Pressure from staff led to a management review of different shift schedules with the most popular schedule adopted. 83% voted for the implemented system. Union and managers were supportive of the intervention. Managers went on 'fact finding' visits to 12hr factories to learn about safety implications and how best to implement the change. Staff input central to the planning and consultation process, key delivery collaborations between staff, union and managers aided implementation.	Depression Absence Accidents General life satisfaction Conflict between work and non-work time Relations with co-workers and supervisors Social/community involvement Planning activities with family Job satisfaction	↑ ↔ ↔ ↑ ↑ ↔ ↔ ↑ ↔
Rosa & Bonnet, 1993 [55]	8 month follow up Final sample: n=10 Methods: 1 7 9 10	Gas Processing Plant, USA. Computer operators, all male.	Four/seven 8hr shifts, two/three days off to Two/three 12hr shifts, two/three days off Intervention initiated by management to make shift work more tolerable.	Few reported details on effectiveness of implementation.	Sleepiness (day) Sleepiness (night) Total sleep time (night) Total sleep time (day) Sleep depth Sleep latency Number of awakenings Exercise Work related adjustment of meal times Work related adjustment of personal schedules	↑ ↔ ↑ ↔ ↔ ↓ ↔ ↔ ↔ ↔ ↔ ↔ ↔

Todd et al, 1993 [56]	6 month follow up Final sample: n=150 Methods: 1 2 4 7 9 10	Hospital, UK. Nurses, mainly female.	Three/four 12hr shifts, three/four days off Intervention initiated by management to increase hospital efficiency. Context of health service reform.	Few reported details on effectiveness of implementation.	Dissatisfaction with fatigue Dissatisfaction with ease of getting childcare Dissatisfaction with amount of time spent with family Dissatisfaction with how personal life is put second	↓ ↓ ↓ ↓
Williamson et al, 1994 [57]	7 month follow up Final sample: n=18 Methods: 1 2 4 7 9 10	Computer Company, Australia. Computer operators (80%) and supervisors (20%).	Two-Five 8hr shifts, one/two days off to Four 12hr shifts, Four days off. Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	Job satisfaction Loss of appetite Gastro-intestinal symptoms Sleep and fatigue Headaches Irritability Heart problems GHQ Visit to doctor Consumption of social drugs Perceptions of work environment	↓ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↔ ↔ ↔ ↔
Freer & Murphy-Black, 1995 [58]	1 month follow up Final sample: n=13 Methods: 1 4 5 6 9	Hospital, UK. Nurses and midwives.	12hr flexible shifts Management tried to reduce costs on 8hr system by decreasing the amount of overlap time on shift changes. Staff disliked this and negotiated the 12hr shift system as a non-compulsory alternative.	Few reported details on effectiveness of implementation. Staff initiated it and were involved with management in designing the pilot.	Job satisfaction Stress Enjoyment at work Morale at work	↔ ↔ ↑ ↑
Campolo et al, 1998 [59]	12 month follow up Final sample: n=20 Methods appraisal: 1 2 4 9	Hospital, Australia. Nurses, all female.	6hr morning shifts, 8hr afternoon shifts, 9.5hr night shifts to Four 12hr shifts, three days off National hospital budget changes meant that expenditure needed to be reduced.	Staff chose the new shift system and persuaded the Union to support their choice. Initially only temporary as the staff were concerned about possible fatigue. However, 91% voted to keep the new schedule after the trial period with 85% citing 'improvement in social life' as their main motivator. Staff input central to the planning & consultation process. Key delivery collaborators between staff, union & managers aided implementation.	Fatigue Gastro-intestinal symptoms Absence Sleep length Sleep quality Work demands Time spent on hobbies Time with family and friends Performance	↑ ↓ ↔ ↔ ↔ ↓ ↑ ↔ ↔

Di Milia, 1998 [60]	2, 3, 4 and 5 month follow ups Final sample: n=3 Methods: 1 5 9 10	Coal mine, Australia. Electricians, all male.	Seven 8hr shifts, two/four days off to Four 12hr shifts, two/eight days off. Few reported details on background to intervention.	Few reported details on effectiveness of implementation. The workforce agreed to the shift change.	Sleep duration	↔
Paley et al, 1994a; 1994b; 1998 [61, 62, 88]	16 month follow up Final sample: n=15 Methods: 1 2 4 5 9 10	Fire Department, USA. Fire fighters, all male.	Five/seven 8hr shifts, two/three days off to Two 10hr day shifts, two 14hr night shifts, four days off. Few reported details on background to intervention.	Few reported details on effectiveness of implementation. The workforce agreed to the shift change.	Sleep length (night) Sleep length (day) Sleepiness	↑ ↔ ↔
Heslegrave et al, 2000 [63]	1 month follow up Final sample: n=120 Methods: 1 2 7 9 10	Metal Canada. Mining operatives, mostly male.	Five 8hr shifts, two days off (weekends) to Two/three/four 10hr shifts, two/three days off. Managers wanted to increase productivity by working on weekends.	Few reported details on effectiveness of implementation. The workforce agreed to the shift change as they wanted the extra day off.	Sleep duration (day) Sleep duration (night) Sleep duration (rest) Tiredness (day) Tiredness (rest) Tiredness (night) Gastro-intestinal problems Headaches Performance (day) Performance (night)	↓ ↔ ↔ ↓ ↓ ↔ ↑ ↑ ↓ ↑
Johnson & Sharit, 2001 [64]	11 month and 8 year follow ups Final sample: n=104 Methods: 1 4 7 8 9 10	Manufacturing Company, USA. Production workers.	8hr rotating shifts to 12hr rotating shifts. Intervention was requested by the employees and they were balloted on the shift change.	Workers were involved in planning the intervention, and they were consulted. Some downsizing occurred over the study period.	Sleep between shifts Sleep difficulties Health disorders Satisfaction with system Productivity Production quality Absence Job satisfaction	↑ ↑ ↑ ↑ ↑ ↑ ↓ ↑*
Von Borkenhagen-Chandler, 2004 [65]	1 month follow up Final sample: n=121 Methods appraisal: 1 7 9	Aerospace Manufacturing Company, USA. Final assembly and Flight test workers.	Five 8hr shifts, two days off to Four 10hr shifts (Mon – Thurs) with three days off or three 12hr shifts (Fri-Sun) with four days off. Company introduced it in order to maintain economic competitiveness.	Few reported details on effectiveness of implementation. Union agreed to a 1 year trial but involvement by individual workers was on a voluntary basis. At the end of the trial, the Union had the option of discontinuation.		↑*

PROSPECTIVE REPEAT CROSS-SECTIONAL STUDIES WITH CONTROL GROUP						
Duchon et al 1994, 1997; Keran et al, 1994# [66-68]	10 month follow-up Final sample: n=22 (17 intervention, 5 control) Methods: 1 4 5 7 9	Metal mine, Canada. Miners.	Seven 8hr shifts, two/three days off to Four 12hr shifts, Four days off. Employer was concerned about fatigue.	Few reported details on effectiveness of implementation. 85% of employees did vote to keep the new system though.	Health problems Eating habits Sleep difficulties after night shift Minor aches and pains Stress <i>Stanford Sleepiness Scale:</i> Sleepiness Sleep length Family life Morale	↔ ↑ ↓ ↓ ↔ ↔ ↔ ↑ ↑
Smith et al, 1998 [69]	6 month follow-up Final sample: n=62 (47 intervention, 15 control) Methods: 1 2 4 5 7 8 9 10	Sewage treatment plant, Australia. Sewage workers.	Seven 8hr shifts, two/ days off to Two/three 12hr shifts, two/four days off Few reported details on background to intervention.	Few reported details on effectiveness of implementation. Employees did were consulted (ballot) on implementing the new system and at the end of the trial period they voted to keep it.	<i>GHQ-12:</i> Psychological complaints Minor health complaints Circadian malaise Muscular complaints Minor infections Day sleep quality Night sleep quality Tiredness Fatigue Physical health Mental health Interference of work with home life Interference of work with social life Work/life satisfaction Work performance Somatic distress Organisational stress Job dissatisfaction	↑ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↑ ↑ ↔ ↔
Cydulka et al, 1994 [70]	1 and 6 month follow-ups Final sample: n=140 (27 intervention, 113 control) Methods: 1 2 4 5 7 8 9 10	Hospital, USA. Ambulance workers and Paramedics.	Six 8hr shifts, two days off to Three 12hr shifts, two days off Introduced to reduce stress.	Few reported details on effectiveness of implementation.	Work/life satisfaction Work performance Somatic distress Organisational stress Job dissatisfaction	↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↑ ↑ ↔ ↔ ↔

PROSPECTIVE REPEAT CROSS-SECTIONAL STUDIES					
Heslegrave et al, 2000 [71]	12 month follow-up Final sample: n=66 Methods: 1 2 4 5 7 9 10	Nuclear Power Plant, Canada. Power plant operators, mainly male.	Three/four/seven 9hr shifts, two/six days off to Four 12.5hr shifts, Four days off. Managers wanted to increase time for training.	Few reported details on effectiveness of implementation. Union was supportive of the change as it increased days off for employees.	Fatigue Sleep Performance ↓ ↔ ↓
Michell and Williamson, 2000 [72]	6 month follow-up Final sample: n=12 Methods: 1 2 4 5 7 9 10	Electrical Power Station, Australia. Power station workers (supervisors, fire fighters, turbine operators), all male.	Seven 8hr shifts, one/two/four days off to Five/six 12hr shifts, two/three/seven days off Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	Health complaints Alcohol consumption Sleep quality Absence Sleep disturbance Sleep length Chronic fatigue Physical health GHQ Somatic Anxiety Feeling stressed Social life Domestic life Coping with social life Coping with home life Work performance ↑ ↑ ↑ ↓ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↑ ↑ ↑ ↑ ↔

‡ Results only presented for the intervention group

* Amongst some workers only

Summary table 3: Compressed work week – retrospective studies (grouped by study design)

Study	Design & Methods Appraisal	Setting & Participants	Background	Implementation	Health/Wellbeing/Economic Outcomes
RETROSPECTIVE COHORT STUDIES WITH CONTROL GROUP					
Venne, 1993; 1997 [73, 74]	Historical data: 12 month pre average, 24 month post average. Final sample: n=102 (70 intervention, 32 control) Methods: 4 5 7 9 10	Prison, Canada. Prison Guards.	Five 8hr shifts, two days off to two/three 12hr shifts, two/three days off Staff requested the change and the local union was supportive. The national union though was against the change as they considered it to be regressive after so much had been done to gain the 8hr day.	Staff requested the change, managers and supervisors were in favour as they saw the change as a way of decreasing sickness absence. A union-management committee planned and implemented the change.	Absence ↑ = improvement ↓ = worsening ↔ = little change
Yamada et al, 2001 [75]	Historical data: 2, 8, 14 and 24 month follow-ups Final sample: n=205 (189 intervention, 16 control) Methods: 2 4 5 6 9	Electronic parts manufacturer, Japan. Processing machine operators.	Five 8hr shifts, two days off to two/three 12hr shifts, two/three days off. Introduced to increase production efficiency.	Few reported details on effectiveness of implementation. The Union agreed to a trial period but expressed concern over excessive workloads.	Lower back pain Stiff shoulder Joint pain Limb pain Dimmed sight Sore throat Poor sleep Diminished alertness Tiredness Irritation Head heaviness BMI Weight Blood pressure ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔

RETROSPECTIVE COHORT STUDIES						
Laundry & Lees, 1989; 1991 [76, 77]	Historical data: 120 month pre average, 120 month post average. Final sample: n=247 Methods: 2 4 5 7 8 9 10	Synthetic yarn factory, Canada. Factory workers, 85% male.	Five 8hr shifts, two days off to 12hr shifts. Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	Morbidity (male) Morbidity (Female) Headaches Gastric upset Diarrhoea Alcohol problems General malaise Nervous conditions Minor injury rate Severe injury rate Injury rate (male) Injury rate (female)	↑ ↔ ↑ ↑ ↑ ↑ ↔ ↔ ↑ ↔ ↑ ↔
Conrad-Beetschart, 1990 [78]	After only recall data: 1 month post. Final sample: n=78 Methods: 2 4 7 9	Oil refinery, Switzerland. Operators, mainly male.	Five 8hr shifts, two days off to two/three 12hr shifts, two/three days off. Management asked researchers to investigate how to improve the shift system. Management concerned about high turnover rates, especially amongst younger workers.	92% of workers said they were prepared to take part in a trial of a new shift roster however, none of the six suggested systems received over 70% support. A joint employee-management committee was therefore set up to design a new roster, taking into account the needs of the workforce. 72% of workers voted in support of a trial of the 12hr roster designed by the committee. After the trial, workers voted to keep the new system on a permanent basis. Management also supportive as turnover decreased.	Sleep Health Leisure time Time with partner	↑ ↔ ↑ ↑
Pollock et al, 1994 [79]	Historical data: 18 month pre average, 18 month post average. Final sample: n=300 Methods: 2 4 5 9	Petrochemical manufacturer and fertiliser manufacturer, Australia. Manufacturing workers. Police Force, Canada. Police Officers.	Five 8hr shifts, two days off to four 12hr shifts, four/six days off. Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	Injury rates	↔
Barter-Trenholm, 1997 [80]	After only recall data. Final sample: n=218 Methods: 2 4 7 9 10	Police Force, Canada. Police Officers.	Five 8hr shifts, one in three weekends off to 12hr shifts, one in two weekends off. Few reported details on background to intervention.	Few reported details on effectiveness of implementation.	Sleep patterns Tiredness Effectiveness	↔ ↔ ↔

Vega & Gilbert, 1997 [81]	After only recall data: 8 month post. Historical data: 12 month pre average, 12 month post average. Final sample: 34 Methods: 2 7 9 10	County Sheriff's Department, USA. Patrol Officers, majority male and white.	Five 8hr shifts, two days off to Three 13.3hr shifts, Four days off. Implemented within a context of falling budgets. Aimed to increase productivity, improve job satisfaction, increase morale, enhance flexibility and reduce turnover.	Few reported details on effectiveness of implementation.	Fatigue Quality of professional lives Quality of personal lives Family and personal activities Productivity	↔ ↑ ↑ ↑ ↑
Richbell et al, 1998 [82]	After only recall data. Historical data: 12 month pre average, 12 month post average. Final sample: n=90 Methods: 2 9	Police Force, UK. Police Officers.	Five 8hr shifts to Ottawa system (9/10hr days 10hr nights). Introduced to ensure that there were sufficient staff at the busiest times.	Few reported details on effectiveness of implementation. 76% of staff voted in favour of the change and at the end of the trial 83% voted to keep the new system.	Health Absence Quality of life Morale Service	↑ ↑ ↑ ↑ ↑
Wootten, 2000a, 2000b [83, 84]	Historical data: 3 month pre average, 3 month post average. Final sample: n=20 Methods: 2 4 5 9	Hospital, UK. Nurses.	7.5hr to 12hr shifts. Introduced to improve staff health and well being.	Staff were consulted over the change, 75% agreed to a pilot. Managers were initially hesitant but then agreed. Colleagues who had implemented similar changes elsewhere were consulted. Implemented via collaborations between staff, supervisors and unions.	Absence Accidents Staffing costs Errors	↓ ↑ ↑ ↑
Baker et al, 2000 [85]	Historical data: 9 month pre average, 12 and 24 month post averages. Final sample: not stated Methods: 2 4 5 7 10	Coal Australia. Miners, maintenance workers, preparation plant workers.	8hr shifts to A: Four 12hr shifts, two/six days off; then from A to B: as system A with addition of three consecutive night shifts and no cap on overtime. Introduced to increase productivity and ensure the survival of the mine.	Employees were consulted about change to system A but not to system B. There was a significant reduction in the size of the workforce when the change to system A occurred. Further downsizing accompanied change to system B.	Absence Injury incident rate	↓ ↑
Bloodworth et al, 2001 [86]	After only recall data. Historical data: 2 month pre average, 2 month post average. Final sample: 16 Methods: 2 4	Hospital, UK Nurses, all female.	Five 7.5hr shifts, two days off to Two 6.25hr shifts, two 12hr shifts, Three days off. Introduced to fit in with European Union Working Time Directive.	Few reported details on effectiveness of implementation. At the end of the pilot, all staff signified a preference for the new system.	Tiredness Absence Child care Performance Staff costs Errors and incidents	↔ ↑ ↑ ↔ ↑ ↑ ↔

Brinton, 1983 [87]	Historical data: 5 month pre average, 5 month post average. Final sample: 76 Methods: 2 4 5 9	Paper Mill, USA. Wood yard workers, all male.	Five 8hr shifts, two days off to Four 12hr shifts, Three/Four days off. Instigated by workers to increase their leisure time.	Workers idea, supported by the Union and supervisors. Company management agreed that they would implement the change if a majority of the workforce supported it. New system designed and agreed with the Union. Committee set up between Union and managers to monitor safety on the new system. Flexibility needed by both Union and management to get the new system implemented.
				Injury frequency rate Absence ↑ ↑

* This study also used qualitative focus groups.

Summary table 4b: Compressed work week interventions – direction of effects for health, psychosocial, and economic outcomes for manufacturing studies (prospective cohort studies only).

Study	Outcomes					
	Health		Wellbeing		Economic	
↑ = improvement; ↓ = worsening; ↔ = little change						
Lowden et al 1998	Easy to fall asleep	↑	Time for social/family activities	↑	Satisfaction with hours	↑
	Rested when wake up	↑				
	Sleep quality	↑				
	Fatigue	↔				
	Sufficient sleep	↔				
	General health	↔				
Rosa et al 1989	Gastro-intestinal state (night)	↑	Adjust personal routine for work	↓		
	Gastro-intestinal state (day)	↔	Missed social events	↔		
	Exercise	↓				
	Napping after shift (night)	↑				
	Napping after shift (day)	↔				
	Stress	↔				
	Total sleep time	↔				
	Number of awakenings	↔				
	Sleep depth	↔				
	Sleep quality	↔				
	Sleep latency	↔				
Jansen & Mull 1990	Fatigue	↔	Time spent with family	↑		
	Gastro-intestinal complaints	↔	Satisfaction with leisure time	↔		
Williams 1992	Depression	↑	General life satisfaction	↑	Job satisfaction	↔
	Absence	↔	Conflict between work and non-work time	↑		
Williamson et al 1994	Loss of appetite	↑	Perceptions of work environment	↔	Job satisfaction	↔
	Gastro-intestinal symptoms	↑				
	Sleep and fatigue	↑				
	Headaches	↑				
	Irritability	↑				
	Heart problems	↑				
	GHQ	↑				
	Visit to doctor	↔				
	Consumption of social drugs	↔				
Johnson & Sharit 2001	Sleep between shifts	↑			Satisfaction with system	↑
	Sleep difficulties	↑			Productivity	↑
	Health disorders	↑			Production quality	↑
VonBorckenhausen-Chandler 2004	Absence	↓			Job satisfaction	↑*

Summary table 5: Changes to shift rotation (grouped by intervention type)

Study	Design & Methods Appraisal	Setting & Participants	Intervention	Background & Implementation	Health/Wellbeing/Economic Outcomes
SPEED OF ROTATION					
Horberger & Knauth, 1995, 1998 [89, 90]	Prospective cohort with control group (T1 and T2), no control group (T3) 8 and 54 month follow-ups Final sample: n=50 (no separate n for intervention and control groups) Methods: 1 7 8 9 10	Chemical industry, Germany. Chemical processing workers, all male.	Intervention(s): Slow to fast rotation Shift systems: Continuous slow rotation 4 shift to continuous fast rotation 5 shift.	Arose because of a change to working hours which meant more shifts were needed Management led and employees were not involved at all in some sections of the plant. Employees supportive though as 98% voted to keep the new system.	<p>↑ = improvement ↓ = worsening ↔ = little change</p> <p>Fatigue ↑ Sleep disturbances ↑ Appetite disturbances ↑ Neurovegetative complaints ↓ Gastrointestinal disorders ↔ Disturbance to social and family life (am) ↑ Disturbance to social and family life (pm) ↔ Disturbance to social and family life (night) ↔</p>
Ng-A-Tham & Thierry, 1993 [91]	Prospective cohort 6 month follow-up Final sample: n=39 Methods: 1 2 4 7 9 10	Railway, Netherlands. Traffic controllers.	Intervention(s): - Slow to fast rotation Shift systems: Slow backward rotating to fast rotating morning and evening (1 fixed evening off). Night shifts remained slow rotating.	Researcher initiated Few reported details on effectiveness of implementation.	<p>Sleep complaints ↑ Fatigue ↔ Leisure time complaints ↔ Domestic and child care problems ↑ Weekly workload ↑ Satisfaction with evening leisure time ↑ Satisfaction with days off ↓</p>
Williamson & Sanderson, 1986 [92]	Prospective repeat cross section 5 month follow-up Final sample: n=26 Methods: 1 2 4 5 7 9 10	Emergency Service, Australia. Control room operators	Intervention(s): Slow to fast rotation Shift systems: Slow rotating 3 shift to a fast rotating 3 shift.	Researcher initiated Few reported details on effectiveness of implementation.	<p>Sleep difficulties ↑ Absence ↑ Headaches ↑ Digestive system disorders ↑ High blood pressure ↑ Diarrhoea ↑ Constipation ↑ Anxiety ↑ Nervousness ↓ Alcohol consumption ↔</p>

Study	Design & Methods Appraisal	Setting & Participants	Intervention	Background & Implementation	Health/Wellbeing/Economic Outcomes
DIRECTION OF ROTATION					
Orth-Gomer, 1983 [93]	Cross over controlled trial 3 and 5 week follow-ups Final sample: n=45 (45 intervention, 45 control) Methods: 1 3 5 7 9 10	Police Force, Sweden. Police Officers	Intervention(s): Backward to forward rotation Shift systems: Fast backward rotation to fast forward rotation	Researcher led Few reported details on effectiveness of implementation.	<p>↑ = improvement ↓ = worsening ↔ = little change</p> <p>Caffeine consumption ↔ Smoking ↔ Work pressure ↑ Peer cohesion ↔ Job involvement ↔ Supervisor support ↔ Autonomy ↔ Task orientation ↔ Clarity ↔ Control ↔ Innovation ↔ Physical comfort ↔ Job satisfaction ↑</p>
Barton et al, 1994 [94]	Prospective cohort with control group 6 month follow-up Final sample: n=263 (92 intervention, 171 control)	Automotive plant, UK. Car production workers, majority male.	Intervention(s): Forward to backward rotation Shift systems: Discontinuous forward slow rotating 3 shift to discontinuous backward slow rotating 3 shift.	Introduced for consistency with other lines in the factory Few reported details on effectiveness of implementation.	<p>Coronary risk factors ↑ Systolic blood pressure ↑ Diastolic blood pressure ↔ Sleep quality (day) ↑ Sleep quality (night) ↑ Sleep duration (day) ↑ Sleep duration (night) ↓ Self-rated health ↔ Tobacco consumption ↔ Work load ↔ Work strain ↔ Satisfaction with amount of leisure time between shifts ↑ Sleep quality (pm) ↓ Sleep quality (am) ↔ Sleep quality (night) ↔ Cigarette consumption ↑ Alcohol consumption ↑ GHQ-12 ↔ Chronic fatigue ↔ Gastrointestinal problems ↔</p>

Study	Design & Methods Appraisal	Setting & Participants	Intervention	Background & Implementation	Health/Wellbeing/Economic Outcomes
	Methods: 1 7 8 9 10				<p>↑ = improvement ↓ = worsening ↔ = little change</p> <p>Sleep difficulties ↔ Sleep onset times ↔ Sleep duration ↔ Social disruption ↑ Domestic disruption ↔ Non-domestic disruption ↔ Social life dissatisfaction ↔ Job dissatisfaction ↔</p>
REMOVAL OF ROTATION					
Owen, 1985 [95]	Prospective cohort with control group 12 month follow-up Final sample: n=239 (122 intervention, 117 control) Methods: 1 2 3 7 9 10	Police Force, USA. Police Officers, mainly white males.	Intervention: rotating to permanent Shift systems: Backward slow rotating 3 shift to permanent shift	<p>Few reported details on background to intervention.</p> <p>Downsizing occurred in both intervention and control groups. This led to an increase in work load for remaining staff. Workers representatives (Police Officers Association) and the employer (City Authority) were involved in the planning and implementation. Workers were given a choice of permanent shift (day, night etc) but ties in choice were settled by seniority. At the end of the trial period the majority of officers rated the new system positively but were still returned to the rotating system.</p>	<p>Trouble sleeping ↑ Trouble digesting ↑ On the job tiredness ↔ Appetite problems ↔ General health ↔ Smoking ↔ Drinking ↔ Headaches ↔ Satisfaction with opportunity to use abilities ↓ Spousal satisfaction with shift schedule ↑ Satisfaction with work load ↔ Satisfaction with co-workers ↔ Satisfaction with supervisors ↔ Satisfaction with time spent with spouse ↔ Satisfaction with time spent with children ↔ Time spent on social activities ↔ Productivity ↑ Job satisfaction ↔ Sleep duration required ↑ Sleep adequacy ↑ Sleep quality ↑</p>
Phillips et al, 1991 [96]	Prospective cohort 4 month follow-up	Police Force, USA. Police Officers.	Intervention: Rotating to permanent	Concern about sleep problems amongst officers on rotating shifts.	

Study	Design & Methods Appraisal	Setting & Participants	Intervention	Background & Implementation	Health/Wellbeing/Economic Outcomes
	Final sample: n=63 Methods: 1 2 9 10		Shift systems: Rotating 3 shift to permanent shift	Few reported details on effectiveness of implementation. However, 57% of workers voted in favour of a 1 year trial of the intervention. They had choice of permanent shift and 88% received their first choice.	↑ = improvement ↓ = worsening ↔ = little change Rested upon awakening Daytime sleepiness Awakening too early Difficulty falling asleep Psychological symptoms (number) Psychological symptoms (severity) Absence

† Morning shift days only. No changes on night and evening shift days.

Summary table 6: Other changes to shift working schedules (grouped by intervention type)

Study	Design & Methods Appraisal	Setting & Participants	Intervention	Background & Implementation	Health/Wellbeing/Economic Outcomes
CHANGES TO NIGHT WORK					
Akerstadt & Torsvall, 1978* [97]	Prospective cohort with control group 12 month follow-up Final sample: n=305 (127 intervention, 178 control) Methods: 1 2 4 5 7 9 10	Steel company, Sweden. Steel workers, majority men.	Intervention: No night shifts Shift systems: 3 or 4 shift system to 2 shift system with no night shifts	Introduced as result of economic problems which required a cut in work hours. Few reported details on effectiveness of implementation. Changes led to a net wage reduction for employees.	↑ = improvement ↓ = worsening ↔ = little change Sleep/mood complaints Gastro-intestinal complaints Shift specific problems Sleep length Absence Social complaints
Smith & Mason, 2001 [98]	Prospective cohort 6 month follow-up Final sample: n=76	Police Force, UK. Police Officers.	Intervention: less consecutive night shifts Shift systems: Ottawa system (with 7 consecutive night shifts) to Ottawa (with a maximum of 4	Managers instigated change as part of a review of the different shift work systems used by the police force. Managers and staff representatives (Police Federation) involved in the design and implementation process. Staff representatives were supportive of the new system as they felt it would benefit their	↓ ↓ ↓ ↔ Night shift fatigue Sleepiness Caffeine intake

Kobayashi et al, 2004 [99]	Methods: 1 2 7 8 9 10 Prospective cohort No details of follow-up Final sample: n=18 Methods: 1 2 4 5 6 7 8 9 10	Hospital, Japan. Nurses, all female.	consecutive night shifts). Intervention: increase of rest period before night shift Shift systems: Irregular rotating 3 shift system with a full day shift (0830-1630) before night shift to irregular rotating 3 shift system with a half day shift (0830-1230) before night shift.	members. Few reported details on background to intervention. Some suggestion it may have been to reduce fatigue on the night shift. Few reported details on effectiveness of implementation. Staff agreed to the change.	Sleep duration before night shift Irritation on night shift Tiredness on night shift	↑ ↔ ↔
LATER START & FINISH TIMES						
Rosa et al, 1996 [100]	Prospective cohort with control group 4 month follow-up Final sample: n=208 (68 intervention, 140 control) Methods: 1 2 4 7 9 10	Steel rolling mill, Finland. Mill workers.	Intervention: later start & finish times Shift systems: Rotating 3 shift system (with shift starts at 0600, 1400, 2200) to rotating 3 shift (with shift starts of 0700, 1500, 2300).	Introduced to reduce sleep and fatigue problems amongst older workers. Workers initially voted in favour of the new system. However, 75% of workers voted against keeping it after the trial period because it interfered with social activities. Those implementing the intervention had experience as another steel plant had already implemented 1hr delays with positive health effects.	Sleep duration (pm) Sleep duration (am, night, rest) Sleep quality (pm, night) Sleep quality (am, rest) Satisfaction with amount of sleep (am) Satisfaction with amount of sleep (pm, night) Satisfaction with amount of sleep (rest) Awaken refreshed from sleep (am) Awaken refreshed from sleep (pm, night) Awaken refreshed from sleep (rest) Health complaints Chronic fatigue Interference of shift work with domestic activities Mental and physical workload Job satisfaction	↑ ↔ ↓ ↔ ↑ ↓ ↔ ↔ ↑ ↓ ↔ ↔ ↓ ↔ ↔
CHANGES TO WEEKEND WORKING						
Boggild & Jeppesen, 2001 [101]	Prospective cohort with control group 6 month follow-up Final sample: n=101	Hospital, Denmark. Nurses.	Intervention: continuous (weekends on) to discontinuous shift system (weekends off) Shift systems: Irregular continuous flexible rotating shift	Researcher led to make shifts more ergonomic Staff, managers and researchers were involved in designing the shift system over a 12 month period. Staff voted to participate in the trial.	HDL Cholesterol (A) Total Cholesterol (A) LDL Cholesterol (A) HDL Cholesterol (B) Total Cholesterol (B) LDL Cholesterol (B)	↔ ↔ ↔ ↓ ↑ ↑

	(41 intervention, 60 control) Methods: 1 2 4 6 7 8 9 10		to A. regular continuous or B. discontinuous regular shift.			
Banks, 1956 [102]	Retrospective cross section After only recall data. Final sample: n=73 Methods: 2 4 7 8 9 10	Steel Factory, UK. Wives of steel workers.	Intervention(s): discontinuous (weekends off) to continuous (weekends on) Shift systems: Discontinuous rotating 3 shift to a continuous rotating 3 shift.	Few reported details on background to intervention. Few reported details on effectiveness of implementation.	Social life Domestic routine Time with husband	↔ ↔ ↔
DECREASED HOURS						
Boudreaux et al, 1998 [103]	Prospective cohort 2 and 12 month follow-ups Final sample: n=35 Methods: 1 2 4 7 9 10	Emergency Services, USA. Paramedics.	Intervention: decrease in shift length Shift systems: 24 hr shifts (1 day on, 2 days off) to 12hr shifts (2/3 days on, 2/3 off) with monthly rotation between day and night shifts.	Few reported details on background to intervention. Few reported details on effectiveness of implementation.	Emotional exhaustion Social and family life Depersonalisation Job satisfaction	↑ ↑ ↔ ↔
Best, 1933 [37]	Retrospective cross section After only recall data. Final sample: n=265 Methods: 2 4 7 9	Factory, USA. Factory workers, all female.	Intervention: decrease in shift length Shift systems: 8 hour three shift to 6 hour four shift	Intervention introduced to increase productivity and decrease costs. In addition to the schedule redesign, 20min lunch breaks were abolished as was the staff canteen. The size of the workforce increased. Few reported details on effectiveness of implementation.	Fatigue Domestic inconvenience Wages	↔ ↔ ↓
SELF-SCHEDULING						
De Haan, 1990 [104]	Prospective cohort with control group 12 month follow-up Final sample: n=50 (25 intervention, 25 control) Methods: 1 7 9 10	Bus Company, Netherlands. Bus drivers.	Intervention(s): Self-scheduling of shifts Shift systems: Irregular to regular self-scheduled.	Introduced to combat the high numbers of complaints from employees, high levels of absence, and low productivity. Few reported details on effectiveness of implementation.	Absence Fatigue Complaints about family life Support from manager Complaints about free time Complaints about time with children Productive work hours	↑ ↑ ↑ ↑ ↔ ↔ ↑
Gauderer & Knauth, 2004 [105]	Prospective cohort with control group	Public transport depot, Germany.	Intervention: Self-scheduling of shifts	Introduced to improve the ergonomic design of shifts by involving drivers in their own scheduling.	Accidents Opportunities to plan	↑ ↑

	<p>12 month follow-up</p> <p>Final sample: n=24 (no details of n for intervention or control groups)</p> <p>Methods: 1 9</p> <p>Prospective repeat cross-section</p> <p>6 month follow-up</p> <p>Final sample: n=45</p> <p>Methods: 1 2 5 9</p>	<p>Bus drivers.</p>	<p>Shift systems: No details provided of shift systems.</p>	<p>Staff, managers and researchers were involved in designing the system. Workers' council voted in favour of the change and at end of the 1 year trial period workers voted to keep the new system. Those involved in implementation collected information from other companies that had experienced a similar intervention. Workers attended training workshops to learn how to design their own schedules.</p>	<p>leisure time</p> <p>Social contacts</p> <p>Customer complaints</p> <p>↑</p> <p>↑</p>
<p>Wortley & Grierson-Hill, 2003 [106]</p>	<p>Hospital, UK.</p> <p>Nurses.</p>	<p>Intervention: Self-scheduling of shifts</p> <p>Shift systems: No details provided of shift systems.</p>	<p>Introduced to give staff more control over their shift patterns.</p> <p>Meetings and consultations occurred between staff and managers before implementation and 'all staff had equal input into the process'. 82% of staff preferred the new system</p>	<p>Work/life balance</p> <p>↑</p>	

* A separate group were exposed to multiple changes (see table 7)

Summary table 7: Multiple interventions

Study	Design & Methods Appraisal	Setting & Participants	Interventions ^B	Background & Implementation	Health/Wellbeing/Economic Outcomes
Akerstadt & Torsvall, 1978 ⁹ [97]	Prospective cohort with control group 12 month follow-up Final sample: n=305 (127 intervention, 178 control) Methods: 1 2 4 5 7 9 10	Steel company, Sweden. Steel workers, majority men.	Intervention(s): Fast to slow rotation, continuous to discontinuous. Shift systems: Fast rotating 4 shift with weekend working to slow rotating 3 shift with weekends off.	Introduced as result of economic problems which required a cut in work hours. Few reported details on effectiveness of implementation. Changes led to a net wage reduction for employees.	↑ = improvement ↓ = worsening ↔ = little change Shift specific problems Sleep length (days) Sleep length (pm, night) Absence Sleep/mood complaints Gastro-intestinal complaints Social complaints
Poole et al, 1982 [107]	Prospective cohort with control group 6 month follow-up Final sample: n=298 (189 intervention, 109 control) Methods: 1 5 7 9 10	Engineering factory, UK. Production line workers	Intervention(s): Slow to fast rotation; Backward to forward rotation Shift systems: Discontinuous slow forward rotating 2 shift to discontinuous fast backward rotating 3 shift.	Implemented due to increased production demands. Factory had a long history of reorganisation of shift work and job insecurity. Unsuccessful negotiations were held between management and unions for a number of months before the change was finally imposed on the workforce.	Difficulties getting up for work Feeling sleepy on the night shift Indigestion problems Arousal Stress Anxiety Depression Alcohol consumption Abdominal pain Heartburn Bowel movements Difficulty going to sleep Visits to doctor Absence Enjoyment of social and sex life Tension at home Enjoyment of work
Bodin, 1983 [108]	Prospective cohort with control group 8 month follow-up Final sample: n=129	Paper Mill, France. Laboratory, maintenance, security workers, machine operators.	Interventions: Slow to fast rotation; Reduction in hours of working week. Shift systems: Continuous backward 3 shift slow rotation to	Instigated by management as a way of ensuring year round productivity. Changes accompanied move to a new automated factory. Many concurrent changes as a result of the move (e.g. departmental reorganisation, improvement of physical working	Tiredness Lack of appetite Digestive disorders Nervous disorders Physical stiffness

	(104 control) intervention, 25 Methods: 1 7 9	all men.	continuous backward 3 shift fast rotation.	conditions, increased team working). Union agreement required by law under 'solidarity agreements'. Decreasing working week an aim of the Union. Reduction in working hours would not lead to a decrease in wages. Factory slightly ahead of the legal requirement to reduce the working week to less than 35hrs for continuous shift workers due to come into effect in France about a year after the intervention anyway. Strikes had occurred at factory in recent years over pay and conditions, the most recent of which had failed. Workers in each department voted on whether they wanted to keep slow rotation or move to fast rotation.	Family life Time on customary activities	↓ ↓
Knauth & Kleisswetter, 1987 [109]	Prospective cohort with control group 6 month follow-up Final sample: n=52 (25 intervention, 27 control) Methods: 1 9 10	Food Processing Factory, Germany. Production and Maintenance workers.	Intervention(s): Slow to fast rotation; Discontinuous to continuous. Shift systems: Backward slow rotating discontinuous system to a fast rotating continuous system	To reduce the high levels of weekend overtime which were in breach of trade union agreements and German law by making weekends part of the regular shift schedule. Shift workers chose the new shift pattern and at the end of the trial, 83.9% voted in favour of the new system even though many received lower wages due to loss of weekend overtime. Researchers designed the shift system in consultation with the management and workers. An additional shift crew were recruited so that weekends could be covered.	Sleep difficulties (night) Sleep difficulties (day) Sleep duration Gastrointestinal symptoms Earnings	↑ ↔ ↔ ↔ ↓
Kandolin & Huida, 1996 [110]	Prospective cohort with control group 6 month follow-up Final sample: n=58 (45 intervention, 13 control) Methods: 1 2 3 4 7 9 10	Hospital, Finland. Midwives, all female.	Interventions: Slow to fast rotation; Backward to forward rotation; Self-scheduling of shifts. Shift systems: Slow backward rotating 3 shift to fast forward rotating self-scheduled 3 shift.	Introduced to reduce fatigue by decreasing the number of 'quick returns' and changing to a forward rotation. To increase role of midwives in their own scheduling. Managers carried out the rescheduling, they had previous experience. Only a third of the midwives said that they had actually experienced a change to forward rotation, but more experienced less quick returns on the new system. A higher proportion of staff now participated in their own scheduling. 55% said they preferred the old system due to the longer continuous free time.	Mental strain during morning shift Mental strain during evening shift Tiredness during night shifts Mental stress Good possibilities to participate in planning own schedule	↔ ↔ ↑ ↔ ↑
Czeisler et al, 1982 [111]	Prospective cohort 3 month follow-up Final sample: n=85 Methods: 1 4 5 7 9 10	Chemical industry, USA. Chemical processing workers	Intervention(s): Fast to slow rotation; Backward to forward rotation. Shift systems: Weekly backward rotating to 3 weeks forward rotating	Introduced because a staff survey revealed that rotating shift workers had worse insomnia than permanent shift workers. Few reported details on effectiveness of implementation.	Health Productivity	↔ ↑
Totterdell & Folkard, 1990 [112]	Prospective cohort 4 month follow-up Final sample: n=20	Police Force, UK. Police Officers	Intervention(s): Slow to fast rotation; Backward to forward rotation; Later start & finish times, self-scheduling.	Few reported details on background to intervention. Few reported details on effectiveness of implementation. Officers did vote narrowly in support of extending the trial period.	Sleep duration Sleep quality Time for social activities Communication with colleagues	↔ ↔ ↑ ↓

Hakola & Harma, 2001 [113]	Methods: 1 7 9 10		Shift systems: A. Weekly backward rotating 3 shift (with shift starts at 0600, 1400, 2200) to rapid forward rotating 3 shift with flexible start times of up to 2 hrs delay (with guideline shift starts of 0700, 1500, 2300). B. Weekly backward rotating 3 shift (with shift starts at 0600, 1400, 2200) to rapid forward rotating 3 shift (with shift starts of 0700, 1500, 2300).		Disruption to personal life (A) Time for social activities (A) Difficulty of planning social life (A) Disruption to personal life (B) Time for social activities (B) Difficulty of planning social life (B)	↓ ↓ ↓ ↑ ↑ ↑
Prospective cohort 12 month follow-up Final sample: n=16 Methods: 1 5 7 9 10	Steel factory, Finland. Factory workers, all male.	Intervention(s): Backward to forward rotation; Slow to fast rotation. Shift systems: Continuous slow backward rotating three shift to a fast forward rotating three shift.	Few reported details on background to intervention. Few reported details on effectiveness of implementation.	Feels rested Quality of sleep Sufficient amount of sleep Easy to fall asleep Wake up when intended	↑ ↑ ↑ ↔ ↔	
Knauth & Hornberger, 1998 [114]	Prospective repeat cross section with control group 10 month follow-up Final sample: n=137 (70 intervention, 67 control) Methods: 1 2 4 5 7 8 9 10	Steel industry, Germany. Steel workers.	Intervention(s): Backward to forward rotation; Slow to fast rotation. Shift systems: A. Discontinuous slow backward rotating or B. Continuous slow backward rotating to A. fast discontinuous forward rotating or B. fast continuous forward rotating.	Researcher led Researchers, workers and managers were involved in planning and implementation. Workers selected a shift system and almost 100% voted in favour of keeping the new shift system.	Health Sleep duration Sleep disturbances Difficulties with social problems Duration of leisure time	↔ ↔ ↔ ↑ ↔

* A separate group were exposed to a decrease in night shifts (see table 6)

Appendix 5: Full results tables

Full results table 8: Compressed work week studies (grouped by study design)

Study	Health/Wellbeing/Economic Outcomes ^A
PROSPECTIVE COHORT STUDIES WITH A CONTROL GROUP	
<p>Barton-Cunningham 1981, 1982</p>	<p>Increase in 'sporting activities' amongst intervention group between T1 and T2 (F=8.8, p<.01) which decreased once 8hr schedule was restored (F=13.5, p<.01): T1 intervention mean= 8.1, control=7.9, T2 intervention= 13.9, control=7.0, T3 intervention=8.5, control=7.0.</p> <p>Less 'absenteeism' in intervention group: T1 intervention mean= 13.1, control=9.2, T2 intervention =8.8, control =26.2.</p> <hr/> <p>Increase in 'time spent with spouse' amongst intervention group between T1 and T2 (F=25.6, p<.01) which decreased once 8hr schedule was restored (F=22.3, p<.01): T1 intervention mean = 5.6, control=5.6, T2 intervention=14.5, control=4.2, T3 intervention=7.4, control=6.5.</p> <p>Increase in 'time spent on family matters' amongst intervention group between T1 and T2 (F=29.5, p<.01) which decreased between once 8hr schedule was restored (F=22.4, p<.01): T1 intervention mean= 6.6, control=7.1, T2 intervention=14.9, control=6.2, T3 intervention=8.4, control=7.4.</p> <p>Increase in 'time spent on domestic chores' amongst intervention group between T1 and T2 (F=14.7, p<.01) which decreased once 8hr schedule was restored (F=22.1, p<.01): T1 intervention mean = 7.8, control=8.6, T2 intervention=16.0, control=6.5, T3 intervention=7.9, control=7.2.</p> <p>Increase in 'time spent socialising with friends' amongst intervention group between T1 and T2 (F=23.4, p<.01) which decreased once 8hr schedule was restored (F=25.7, p<.01): T1 intervention mean= 5.2, control=5.9, T2 intervention=14.0, control=4.5, T3 intervention=6.5, control=5.6.</p> <hr/> <p>NS change in job satisfaction measures of opportunity for skill, ability to use skills, and long run potential of the job.</p>
<p>Barton-Cunningham 1989</p>	<p>'Absence' decreased by 73% from T1 to T2 in the intervention group compared to only a 2% reduction in the control group.</p> <p>'Accidents' decreased by 69% in the intervention group compared to an increase of 10% in the control group.</p> <p>NS difference for 'sleep problems during the day shift', 'sleep problems during the night shift' or 'tiredness' (T1 intervention mean = 1.8, control= 2.1, T2 intervention= 2.1, control= 2.0).</p> <hr/> <p>NS difference for 'tensions due to job' or 'tensions due to people around (Kahn et al scale).</p> <p>NS difference for 'job characteristics' (Hackman and Oldham Job Diagnostic Survey)</p> <p>NS difference for 'family satisfaction'</p> <hr/> <p>NS difference for 'satisfaction with work'</p>
<p>Totterdell & Smith 1992</p>	<p>Significant improvement compared to control group in GHQ scores: T1 control mean = 11.0, T2 control = 11.9, T1 intervention = 11.2, T2 intervention = 7.1, (F1,69=15.56, p<.001).</p> <p>Significant improvements in the intervention group were also reported in terms of: Insufficient sleep (T1 control mean = 53.6, T2 control = 53.9, T1 intervention = 45.0, T2 intervention = 14.1, F1,67=17.83, p<.001), fatigue (T1 control mean =</p>

	<p>53.0, T2 control = 51.4, T1 intervention = 45.7, T2 intervention = 13.0, F1,67=18.47, p<.001), headaches (T1 control mean = 23.5, T2 control = 27.7, T1 intervention = 30.8, T2 intervention = 7.3, F1,67=13.89, p<.001), stomach aches (T1 control mean = 25.0, T2 control = 27.3, T1 intervention = 20.1, T2 intervention = 5.3, F1,67=8.88, p<.01), sleep duration (T1 control mean = 7.87, T2 control = 7.76, T1 intervention = 7.3, T2 intervention = 7.7, F1,67=11.34, p<.001), stress (T1 control mean = 41.0, T2 control =45.9 , T1 intervention = 35.2, T2 intervention =9.2 , F1,67=21.74, p<.001), feeling unwell (T1 control mean =47.2 , T2 control = 39.3, T1 intervention = 39.4, T2 intervention = 7.7, F1,67=8.41, p<.01), irregular meals (T1 control mean = 60.9, T2 control = 61.8, T1 intervention = 53.8, T2 intervention = 19.6, F1,67=19.4, p<.001). However, for these measures, there were significant between group differences at baseline.</p> <hr/> <p>NS difference in sleep quality.</p> <hr/> <p>Significant improvements reported in the intervention group: Insufficient time for family (T1 control mean = 63.8, T2 control = 62.6, T1 intervention = 56.4, T2 intervention = 15.5, F1,67=41.61, p<.001), Insufficient time for friends (T1 control mean = 63.1, T2 control = 68.1, T1 int = 52.0, T2 int = 14.1, F1,67=38.17, p<.001), Insufficient time for social life (T1 control mean = 66.5, T2 control = 68.6, T1 intervention = 57.9, T2 intervention = 15.6, F1,67=31.29, p<.001), Personal life disrupted (T1 control mean = 57.4, T2 control = 58.3, T1 intervention = 49.5, T2 intervention =21.9, F1,67=19.27, p<.001), planning social life difficult (T1 control mean = 58.3, T2 control = 66.0, T1 intervention =61.4, T2 intervention = 12.0, F1,67=62.02, p<.001), Domestic arrangements difficult (T1 control mean = 56.4, T2 control = 59.8, T1 intervention = 61.3, T2 intervention = 15.6, F1,67=19.68, p<.001), poor relations with family (T1 control mean =43.7 , T2 control = 48.3, T1 intervention =43.7 , T2 intervention = 8.7, F1,67=34.06, p<.001), Not enough free time (T1 control mean = 65.9, T2 control =65.7 , T1 intervention = 68.7, T2 intervention = 12.3, F1,67=75.66, p<.001). However, for these measures, there were significant between group differences at baseline.</p> <hr/> <p>Significant improvements reported in the intervention group: less effective at work: (T1 control mean = 30.7, T2 control = 33.9, T1 intervention = 28.8, T2 intervention = 6.2, F1,67=13.73, p<.001), fatigue affects work (T1 control mean = 40.9, T2 control = 40.7, T1 intervention =35.1 , T2 intervention = 10.7, F1,67=15.58, p<.001). However, for these measures, there were significant between group differences at baseline.</p>
<p>Lowden et al 1998</p>	<p>Improvement in 'easy to fall asleep' (1-5, never – always) in intervention group compared to control: T1 intervention mean= 3.59, T2 intervention= 4.12, T1 control= 4.31, T2 control= 4.23 (p<.05).</p> <p>Improvement in 'rested when awakening' 1-5, never – always) in intervention group compared to control: T1 intervention mean=4.06, T2 intervention= 4.47, T1 control= 4.38, T2 control= 4.23 (p<.05).</p> <p>Improvement in 'sleep quality' in intervention group (F=9.1, p<.01).</p> <p>NS difference in 'fatigue', 'sufficient sleep', or 'general health'.</p> <hr/> <p>Increase in 'time for social/family activities' (1-4, not at all - very much): T1 intervention mean= 2.65, T2 intervention= 3.02, T1 control= 3.25, T2 control= 3.02 (p<.05).</p> <hr/> <p>Improvement in 'satisfaction with work hours' (1-5, not - very satisfied): T1 intervention mean= 3.53, T2 intervention= 4.62, T1 control= 4.29, T2 control= 4.50 (p<.05).</p>
<p>Smith et al 1998</p>	<p>'Sleep duration on the day shifts' (Standard Shiftwork Index) increased (F=11.32, p<.01). But this effect disappeared when shift work experience was controlled for.</p> <p>'Sleep quality' (Standard Shiftwork Index) on rest days decreased (F = 6.28, p<.05). But this effect disappeared when shift work experience was controlled for.</p> <p>NS change 'chronic fatigue', 'physical health' or 'GHQ-12'.</p> <p>Differences between sites:</p> <p>'Sleep duration' (hours) increased on the day shift at site A compared to site B: T1 site A mean= 5.2, T2 site A = 6.6; T1 site B mean = 5.9, T2 site B mean = 6.7 (F= 28.3, p<.001).</p>

	<p>'Sleep quality' improved at site A compared to site B: T1 site A mean= 2.85, T2 site A mean= 3.4; T1 site B mean= 2.8, T2 site B mean= 2.65 (F = 4.59, p<.05).</p> <p>GHQ-12 improved at site A compared to site B (inverse scoring): T1 site A mean= 0.86, T2 site A = 0.68; T1 site B mean= 0.75, T2 site B mean= 0.9 (F = 5.11, p<.05)</p> <p>NS difference 'chronic fatigue' or 'physical health'</p> <hr/> <p>'Workload' (Standard Shiftwork Index) increased slightly T1 to T2 in the trial group but decreased slightly for the controls (F = 6.94, p<.05). But this effect disappeared when shift work experience was controlled for.</p> <p>NS change in 'work pace control' or in levels of 'social/domestic interference'.</p> <p>NS difference between sites.</p>
PROSPECTIVE COHORT STUDIES	
Stinson & Hazlett, 1975	<p>NS improvement in percentage of staff agreeing that they did 'not feel tired on the job' (64% to 72%).</p> <hr/> <p>Percentage of staff agreeing that they had the 'opportunity to use skills' improved from 73% of to 88% (p<.05).</p> <p>Percentage of staff agreeing that they were satisfied with 'time available for recreation' improved from 70% to 84% (p<.05).</p> <p>NS improvement in 'No confusion in work roles' (61% to 76%), 'Cooperative problem solving' (75% to 92%).</p> <p>NS decrease in 'Not feeling overloaded with work' (58% to 54%).</p> <p>NS change in 'opportunity to make decisions'.</p>
Eaton & Gottselig, 1980	<p>Personal Health Survey: Decrease in general health complaints (t=2.56, p<.017), cardiovascular complaints (t=4.14, p<.0001), anxiety (t=3.39, p<.003), and anger-frustration (t=2.33, p<.029).</p> <p>Nurses perception questionnaire: Fatigue decreased (chi=6.75, p<.005), and nurses felt more rested (chi=5.14, p<.05).</p> <p>Administrative data: NS change in sickness absence or accidents and injuries.</p> <hr/> <p>Work environment scale: Decrease in managerial control (t=-2.67, p<.01); increase in staff innovation (t=2.83, p<.01) and autonomy (t=1.87, p<.04); decrease in role clarity (t=-1.90, p<.04).</p> <hr/> <p>Minnesota Satisfaction Questionnaire: NS increase in job satisfaction.</p> <p>Administrative data: Staff turnover decreased, NS change in incidents and errors.</p>
Peacock et al, 1983	<p>Significant increase in sleep duration from 6.24 hours a night to 6.52 hours per night.</p> <hr/> <p>NS change in alertness</p>
Rosa et al, 1989; Lewis & Swaim, 1986; Rosa, 1991	<p>Gastro-intestinal state (1-9, nausea-fine) on the night shift improved: T1 night = 6.77, T2 night = 7.08 (mean difference = -0.31, 95% CI - 0.91 : 0.29). NS change in day shift.</p> <p>Percentage of people exercising decreased: T1 day = 38%, T2 day = 25% (mean difference = 13, 95% CI 1.48 : 24.52), T1 night = 34%, T2 night = 19% (mean difference = 15, 95% CI 4.68 : 25.32).</p> <p>Percentage of people napping after night shift decreased from 29% to 18% (mean difference = 11 95% CI 3.45 : 18.55). NS change after day shift.</p> <p>NS change in self-reported stress, total sleep time, number of awakenings, sleep depth, sleep quality, sleep latency.</p> <hr/> <p>Percentage of people reporting that they adjusted their 'personal routine to fit work' decreased: T1 day = 6%, T2 day = 2% (mean difference = 4, 95% CI 0.86 : 7.14), T1 night = 15%, T2 night = 7% (mean difference = 8, 95% CI 1.42 : 14.58).</p>

	<p>NS change in missed social events.</p>
Jansen & Mull, 1990	<p>NS decrease in Fatigue (inversely scored, from mean of 3.3 to 3.4 in full-time workers, and 2.9 to 1.9 in part-timers, $p > .05$)</p> <p>NS increase in Gastro-intestinal complaints (from mean of 0.17 to 0.24 in full-timers, $p > .05$). NS decrease amongst part-time workers (from 0.16 to 0.11, $p > .05$).</p> <hr/> <p>Significant increase in Time spent with family (inversely scored, from mean of 4.0 to 2.5 in full timers, and 2.0 to 1.4 in part-timers, $p < .05$)</p> <p>NS increase in Satisfaction with leisure time (from mean of 5.0 to 5.5 in full-timers, and 8.1 to 8.8 amongst part-timers, $p > .05$)</p>
Slota & Balas-Stevens, 1990	<p>Seasonally adjusted sick leave: decreased from 2,688 hours (or 336 shifts) before the intervention to 2,006 (167.2 shifts) during the intervention</p> <hr/> <p>NS change in 'concern about scheduling of vacation time'.</p> <p>NS change in 'ability to request time off'.</p> <hr/> <p>NS change in seasonally adjusted incidents and errors rate.</p> <p>NS change in self-reported personal productivity.</p>
Pierce & Dunham, 1992	<p>Decrease in symptoms of physiological stress (Patchen 1970 5 point scale): T1= 2.93, T2= 2.11, mean difference= 0.82 (95% CI 0.57 : 1.07).</p> <p>Decrease in fatigue (Dunham et al, 1987 5 point scales): T1= 3.50, T2= 2.76, mean difference= 0.74 (95% CI 0.43 : 1.05).</p> <p>Decrease in stress (Gardner and Warwick 5 point scale): T1= 2.37, T2= 2.01, mean difference= 0.36 (95% CI 0.13 : 0.59).</p> <hr/> <p>Extent of work schedule interference with personal activities (Dunham and Pierce 1986 5 point inverse scales) decreased: family and friends T1= 4.10, T2= 2.46, mean difference= 1.64 (95% CI 1.36 : 1.92); social events T1= 3.35, T2= 2.37, mean difference= 0.98 (95% CI 0.73 : 1.23).</p> <p>Satisfaction with leisure time (Dunham and Herman 1975, 7 point scales) improved: T1= 4.08, T2= 6.00, mean difference= -1.92 (95% CI -2.48 : -1.36).</p> <p>Life satisfaction (Dunham and Herman 1975, 7 point scales) improved: T1= 4.78, T2= 5.44, mean difference= -0.66 (95% CI -1.16 : -0.16).</p> <p>NS change in satisfaction with 'organisational association' or 'workload'.</p> <hr/> <p>Job satisfaction (Dunham and Herman 1975, 7 point scales) improved: T1= 4.10, T2= 4.74, mean difference= -0.64 (95% CI -1.25: -0.03).</p> <p>Organisational effectiveness (Police Foundation 1990 5 point scale) improved: work coordination (T1= 2.75, T2= 4.04, mean difference= -1.29; 95% CI -1.57: -1.01) and service response times (T1= 2.59, T2= 3.73, mean difference= -1.14; 95% CI -1.44 : -0.84) improved.</p> <p>NS change in performance.</p>
Williams, 1992	<p>Depression (1-5, never-nearly all the time) decreased: T1 mean = 2.43, T2 mean = 2.12 (t=2.32, $p < .05$)</p> <p>NS change in sickness absence or accidents.</p> <hr/> <p>General life satisfaction (1-4, very happy-not at all happy): increased: T1 mean = 2.45, T2 mean = 2.15 (t=3.03, $p < .01$)</p> <p>Conflict between work and non-work time (1-4, very difficult-easy) decreased: T1 mean = 2.42, T2 mean = 2.77 (t=2.64, $p < .01$). Also improvement in ease of planning activities with families (t=5.15, $p < .001$).</p> <p>NS change in relationships with co-workers and supervisors, or social/community involvement.</p>

	<p>NS change in job satisfaction</p>
Rosa & Bonnet, 1993	<p>Sleepiness (1-7, least-most) decreased on day shift: T1 day mean = 3.34, T2 day mean = 2.33 (mean difference 1.01 = 95% CI = 0.12 : 1.90). NS change on night shift.</p> <p>Total sleep time (minutes) increased on night shifts: T1 night mean = 353, T2 night mean = 441 (mean difference = -88 95% CI = -126.54 : -49.46). NS change on day shift.</p> <p>Less deep sleep (1-9, light-deep): T1 day mean = 8.02, T2 day mean = 6.85 (mean difference = 1.17 95% CI = 0.48 : 1.86). T1 night mean = 7.30, T2 night mean = 5.88 (mean difference = 1.42 95% CI = 0.50 : 2.34).</p> <p>NS change: Sleep latency, number of awakenings, minutes of daily exercise.</p>
	<p>NS change: Work related adjustment to meal times or personal schedules.</p>
Todd et al, 1993	<p>All outcomes measured on Clark 1975, 5 point scale 1-5, strongly agree-strongly disagree.</p> <p>Increased dissatisfaction with physical fatigue at end of shift: T1 mean = 3.8, T2 mean = 4.5, mean diff = -0.7 (95% CI -0.90 : -0.50)</p> <p>Increased dissatisfaction with mental fatigue at end of shift: T1 mean = 3.2, T2 mean = 4.0, mean diff = -0.8 (95% CI -1.07 : -0.53)</p>
	<p>All outcomes measured on Clark 1975, 5 point scale 1-5, strongly agree-strongly disagree.</p> <p>Increased dissatisfaction with ease of getting child care whilst on shift: T1 mean = 3.2, T2 mean = 4.0, mean diff = -0.8 (95% CI -1.03 : -0.57)</p> <p>Increase in dissatisfaction with amount of time spent with family: T1 mean = 3.2, T2 mean = 4.1, mean diff = -0.9 (95% CI -1.12 : -0.68)</p> <p>Increase in dissatisfaction with how personal life is put second: T1 mean = 3.7, T2 mean = 4.2, mean diff = -0.5 (95% CI -0.72 : -0.28)</p>
	<p>Decrease in job satisfaction (Clark 1975, 5 point scale 1-5, strongly agree-strongly disagree): T1 mean = 2.2, T2 mean = 2.6, mean diff = -0.4 (95% CI -0.59 : -0.21)</p>
Williamson et al, 1994	<p>Reports of symptoms decreased (Chi = 25.3, p<.001): loss of appetite (34% to 11%), gastro-intestinal symptoms (constipation 22% to 12%, diarrhoea 29% to 11%, upset stomach 39% to 29%) sleep and fatigue (wake up tired 61% to 34%, tired during shift 45% to 6%, tired after night shift 50% to 44%, tired after day shift 61% to 29%), headaches 56% to 33%, irritability 45% to 5%, heart problems (unusual heart rate 18% to 6%, feeling faint 11% to 6%), breathlessness 18% to 11%.</p> <p>GHQ scores improved: T1 mean = 5.83, T2 mean = 1.56 (t=2.48, p<.02). Percentage classified as 'psychologically distressed' also decreased: T1 = 44.4% and T2 = 11.1% (chi=4.08, p<.05).</p> <p>NS change for visits to doctors or consumption of social drugs.</p>
	<p>NS change in job satisfaction or perceptions of work environment.</p>
Freer & Murphy-Black, 1995	<p>No change in levels of stress (from mean of 3.0 to 3.0) (Five point job satisfaction scale, 1-5, poor – excellent).</p> <p>Improvements in 'enjoyment at work' (increase from mean of 3.2 to 3.6) and 'morale at work' (2.2 to 3.1). (Five point job satisfaction scale, 1-5, poor – excellent).</p>
Campolo et al, 1998	<p>Physical health: slight reduction in fatigue and a slight increase in gastrointestinal symptoms (no data presented)</p> <p>NS change in sickness absence, sleep length, or sleep quality.</p> <p>Mental and physical work demand – demands and frustrations were higher on the longer 12hr night shift. But NS change for other shifts.</p>

	<p>Increase in time on hobbies and membership of organisations (no data presented).</p> <p>NS change in spending time with family and friends.</p> <hr/> <p>NS change in self-rated or objective performance.</p>
Di Milia, 1998	NS change in mean sleep duration.
Paley et al, 1994a; 1994b; 1998	<p>Increase in sleep length (San Diego Naval Medical Research Centre Sleep Log) of 50mins on the night shift ($F_{1,14}=8.71$, $p<.01$). But NS change on the day shift. Night shift change could be due to ability to sleep at station during new night shift and an earlier start time for new day shift.</p> <p>NS change in sleepiness scores.</p>
Heslegrave et al, 2000	<p>Decrease in sleep duration on day shifts: T1 mean = 6.6, T2 mean =6.3, mean difference = -0.3 ($t_{336}=2.43$, $p<.01$). NS change in sleep duration on night shifts or days off.</p> <p>Tiredness (1-5, refreshed to tired) increased on the day shifts (T1 mean = 3.1, T2 mean =4.0, mean difference = 0.9; $t_{341}=4.77$, $p<.001$) and days off (T1 mean = 2.0, T2 mean =2.5, mean difference = 0.5; $t_{317}=3.7$, $p<.001$). NS change in tiredness on the night shifts.</p> <p>Decrease in gastrointestinal problems (1-6, never-always): T1 mean = 2.4, T2 mean =2.0, mean difference = -0.4 ($t_{328}=2.35$, $p<.01$)</p> <p>Decrease in headaches (1-6, never-always): T1 mean = 2.7, T2 mean =2.4, mean difference = -0.3 ($t_{330}=2.07$, $p=.03$).</p> <hr/> <p>Performance was impaired (1– 6, no impairment-extreme) on the day shift: T1 mean = 1.5, T2 mean = 2.5, mean difference = 1.0 ($t_{323}=7.7$, $p<.001$) . Performance improved on night shift: T1 mean = 3.1, T2 mean = 2.7, mean difference = -0.4 ($t_{292}=1.91$, $p<.05$).</p>
Johnson & Sharit, 2001	<p>Increase in percentage sleeping over 6 hrs between shifts from 47.2% - 80.6% to 66% - 81.2% ($p<.001$).</p> <p>Improvement in sleep difficulties: T1 71.5% reported sleep difficulties, T2 40.5%, T3 36.5% ($p<.001$).</p> <p>Improvement in reported disorders (such as heart burn, acid stomach, diarrhoea): T1 43.8% reported disorders, T2 27%, T3 21.2% ($p<.001$).</p> <hr/> <p>More satisfaction with the new shift system than the old ($\chi^2=448.1$, $p<.001$):77.6% very satisfied (49.8%)or satisfied (27.8%) with the new system compared to 75.3% dissatisfied (27.9%) or very dissatisfied (47.4%) with the old system.</p> <p>Improvement in productivity: T1 25.3% reported it was 'easy to achieve high productivity', compared to T2 46.9%, T3 64.1% ($p<.001$)</p> <p>Improvement in production quality: T1 27.2% reported it was 'easy to achieve high quality work', compared to T2 50.4%, T3 67% ($p<.001$).</p>
Von Borkenhagen-Chandler, 2004	<p>Sickness absence decreased from a mean of 11.39 to 4.69 amongst the Final Assembly workers, and from 10.81 to 4.56 amongst the Flight Test workers.</p> <hr/> <p>Job satisfaction (1-5, very dissatisfied to very satisfied) increased amongst Flight Test workers ($F=5.6$, $p=.019$). NS change amongst Final Assembly workers.</p>
PROSPECTIVE REPEAT CROSS SECTION STUDIES WITH CONTROL GROUP	
Duchon et al 1994, 1997; Keran et al, 1994	<p>Results only presented for the intervention group:</p> <p>85% reported the same or fewer health problems under the new schedule.</p> <p>77% reported improved eating habits.</p> <p>Increase in sleep difficulty after the night shift: 47% at T1 and 54% at T2 reported difficulty.</p> <p>Those reporting minor aches and pains towards the end of the week increased from 12% to 14%.</p>

	<p>NS change in Stanford Sleepiness Scale, or in sleep length.</p> <hr/> <p>100% reported the same or less stress under the new schedule</p> <p>93% reported the same or improved family life.</p> <hr/> <p>80% of respondents said that new schedule enhanced morale</p> <hr/> <p>100% of respondents said that absences either decreased or stayed the same.</p>
Smith et al, 1998	<p>Fewer psychological complaints (GHQ-12) in intervention group compared to control group: T1 intervention mean = 22.5, T2 intervention mean = 19.3. T1 control mean = 20.8, T2 control mean = 23.5. (t45= -4.26, p<.000).</p> <p>NS difference for: Minor health complaints, Circadian malaise, Muscular complaints, Minor infections, Day sleep quality, Night sleep quality, Tiredness, Fatigue, Physical health, Mental health.</p> <hr/> <p>Decrease in interference of work with home life in intervention compared to control group: T1 intervention mean = 9.8, T2 intervention mean = 15.4. T1 control mean = 9.5, T2 control mean = 10.4 (t42=6.17 p<.000).</p> <p>Decrease in interference of work with social life in intervention compared to control group at T2: T1 intervention mean =10.2 , T2 intervention mean = 17.7. T1 control mean = 12.3, T2 control mean = 11.2 (t42=6.64, p<.000)</p> <hr/> <p>NS difference for: Work/life satisfaction, or Work performance.</p>
Cydulka et al, 1994	<p>NS difference between intervention and control in somatic distress (T3 intervention mean =19.00, control mean =18.73, mean difference = -0.27 95% CI -1.91: 1.37).</p> <p>NS difference between intervention and control in organisational stress (T3 intervention mean =15.11, control =16.13, mean difference = 1.02 95% CI -0.02 : 2.02).</p> <hr/> <p>NS difference between intervention and control in job dissatisfaction (T3 intervention mean=16.41, control =15.98, mean difference = -0.43 95% CI -1.60 : 0.74).</p>
PROSPECTIVE REPEAT CROSS SECTION STUDIES	
Heslegrave et al, 2000	<p>Fatigue increased (1-6, never-always): T1 mean = 3.5, T2= 4.0, (t162=2.08, p=0.3).</p> <p>Increase in residual fatigue (1-6, very tired-very refreshed): Night T1 mean: 2.7, T2 3.3 (p<.05); Day T1 3.3, T2 3.7 (p<.02), days off T1 1.9, T2 2.5 (p<.01).</p> <p>NS change in sleep.</p> <hr/> <p>Performance (performance impairment 1-6, no-extreme impairment) decreased for both day (t162=7.23,p<.001) and night (t162=4.75, p<.001): T1 Day mean =1.8, night = 3.3, T2 Day = 3.5, night = 4.5.</p>
Mitchell and Williamson, 2000	<p>Health complaints decreased (t=2.07, p<.05). However, 40% of baseline compared to 25% of follow up smoked.</p> <p>Alcohol consumption to aid sleep between consecutive night shifts decreased from 47% to 17%.</p> <p>Sleep quality improved (F1,58 = 26.03, p<.0001), employees were more refreshed after sleep (F1,58= 27.55, p<.0001), and they slept more deeply (F1,58= 10.85, p<.002). Sleep patterns were less disrupted: F1,58= 4.65, p<.04) and employees woke up less often (F1,58 = 6.45, p<.014).</p> <p>Sick leave increased by 12% during the 12hr roster (but this was due to repeated illness of one person).</p> <p>NS difference in sleep disturbance scores; sleep length, chronic fatigue; physical health (cardiovascular health, digestive health); GHQ scores; Cognitive-Somatic Anxiety Questionnaire, feeling stressed.</p> <hr/> <p>Social life (T1 mean = 9.20, T2 = 14.42, t=-2.62, p<.015) and domestic life improved (T1 mean = 14.93, T2 = 24.58, t=-4.18, p<.0001). Coping with social life (t=2.11, p<.045) and coping with home life (t=2.77, p<.01) improved.</p>

	NS change in work performance (t=1.8, ns; t=0.84, ns).
RETROSPECTIVE COHORT STUDIES WITH CONTROL GROUP	
Venne, 1993; 1997	NS increase in sickness absence (mean number of days): T1 intervention mean= 9.34, T1 control mean= 7.55, T2 intervention mean= 12.46, T2 control mean= 8.49 (mean difference= 3.12, 95% CI -0.30:6.54).
Yamada et al, 2001	NS difference between intervention group and control group at any follow-up for: self-reported physical health symptoms (lower back pain, stiff shoulder, joint pain, limb pain, dimmed sight, sore throat), self-reported psychological health symptoms (poor sleep, head heaviness, diminished alertness, tiredness, irritation, unwillingness to go to work), physician examined BMI, weight (kg), or blood pressure.
RETROSPECTIVE COHORT STUDIES	
Laundry & Lees, 1989; 1991	<p>Decrease in age and sex standardised total morbidity ratio (medical records) from 1.00 (95% CI 0.98:1.03) to 0.50 (95% CI 0.49:0.51). Decrease in total morbidity amongst men (from 1.02, 95% CI 1.00:1.05 to 0.47 95% CI 0.46:0.48) but ns decrease amongst women (from 0.76, 95% CI 0.71:0.82 to 0.67 95% CI 0.63:0.71).</p> <p>Decreases in headaches (from 1.06, 95% CI 1.03:1.09 to 0.47, 95% CI 0.46:0.49); gastric upset (0.94, 95% CI 0.90:0.98 to 0.52, 95% CI 0.50:0.54); diarrhoea (from 0.81, 95% CI 0.71:0.90 to 0.54 95% CI 0.48:0.60); and alcohol problems (from 0.62, 95% CI 0.49:0.77 to 0.12 95% CI 0.07:0.18).</p> <p>NS increase in general malaise.</p> <p>NS decrease in nervous conditions.</p> <p>Decrease in age and sex standardised total injury rate (mean pre 1.71, 95% CI 1.63:1.79; mean post 1.08 95% CI 1.03:1.14), minor (first aid required) injury rate (mean pre 1.77, 95% CI 1.68:1.87, mean post 1.12, 95% CI 1.06:1.18) and medical (visit to nurse required) injury rate (mean pre 1.59, 95% CI 1.36:1.84, mean post 0.92, 95% CI 0.79:1.05).</p> <p>NS change in severe (time off work required) injury rate.</p> <p>Injury rates for men for all injury and minor and medical were higher than for women on the 8hr shift. Male injury rates decreased on the 12hr shifts, but women experienced ns decrease.</p>
Conrad-Beetschart, 1990	<p>55.8% said the change from 8hr to 12hr shifts had a positive effect on their sleep.</p> <p>42.9% said the change from 8hr to 12hr shifts had a positive effect on their health.</p> <hr/> <p>78.6% said the change from 8hr to 12hr shifts had a positive effect on their leisure time.</p> <p>63.2% said the change from 8hr to 12hr shifts had a positive effect on their time with their partner.</p>
Pollock et al, 1994	NS change in injury frequency rates.
Barter-Trenholm, 1997	<p>42% said that sleep patterns had improved, 23% said that they had got worse.</p> <p>64% reported feeling no more tired after a 12hr shift than an 8 hr shift.</p> <hr/> <p>81% felt that their effectiveness had improved.</p>
Vega & Gilbert, 1997	<p>80% said that the new system did not increase fatigue. Of the 20% that did experience fatigue it was towards the middle and end of the shift.</p> <hr/> <p>97.1% said that the new system did not erode the quality of their professional or personal lives.</p> <p>Compared to old system, 76.5% found it easier to conduct family and personal activities, 85.3% that it is 'easier' or 'much easier' to devote time to family members.</p> <p>80% preferred the new CWW system.</p> <hr/> <p>Productivity increased (Response time decreased from an average of 12.1 minutes to 11.8, t=-420.9, p<.001)</p>

	<p>88.3% reported that the new system improved their productivity, 94.1% that it created a more favourable attitude to work.</p> <p>88.3% said the new system provided them with more time to supplement their wages with other work.</p>
Richbell et al, 1998*	<p>66% said that their health had improved, 17% said no change. The other 17% were new staff (so could not make a recall control).</p> <p>Sickness absence: 1 year average pre change was 7.2 days per person per annum, after change this reduced to 6.7 days. A reduction of 6.7%.</p> <hr/> <p>88% said that new system improved their quality of life outside of work.</p> <hr/> <p>81% claimed an improvement in morale.</p> <p>73% said that service to the public had improved.</p>
Wooten, 2000a, 2000b	<p>Sickness absence increased from 17 days to 24 days.</p> <p>Accidents decreased from 14 to 13.</p> <hr/> <p>Cost of staffing increased by 2.9%.</p> <p>Drug errors increased from 0 to 1.</p>
Baker et al, 2000	<p>Increase in average monthly absence rates (percentage of employees absent from work for any length of time) amongst the maintenance workers: Pre = 1.8, post A= 2.3, post B = 4.8 ((F2,24= 19.186, p<.05). Post-hoc tests show increase is post B compared to pre and post A.</p> <p>NS change in absence rates amongst the miners and the preparation plant workers.</p> <p>Decrease in incident frequency rate in preparation plant workers: pre= 205, post A= 60, post B= 140 (F2,30= 3.41, p<.05). Post-hoc tests show increase is post A compared to pre, ns increase post A compared to post B. NS change amongst miners or maintenance workers.</p>
Bloodworth et al, 2001	<p>80% said that they did not feel any more tired on the new system.</p> <p>Sickness absence (days lost due to sickness) decreased by 20%.</p> <hr/> <p>All staff with children noted that it was easier to arrange care on the new system as there were less days to consider.</p> <hr/> <p>100% did not consider the change detrimental to their performance</p> <p>Cost of agency nurses to cover sickness absence decreased by 40%.</p> <p>No change in reported number of errors and incidents.</p>
RETROSPECTIVE REPEAT CROSS SECTION STUDIES	
Brinton, 1983	<p>Decrease in injury frequency rate (number of injuries x 1,000,000/hours worked) from 274 to 262.</p> <p>Sickness absence decreased (no data provided).</p>

^ASpecific scales and measures used are also recorded when cited in studies. Similarly, statistical detail varies depending on the amount of information available in the original studies.

Full results table 9: Changes to shift rotation (grouped by intervention type)

Study	Health/Wellbeing/Economic Outcomes ^A
SPEED OF ROTATION	
Hornberger & Knauth, 1995, 1998	<p>Fatigue (0-100, low-high number of disturbances): reduction in intervention group compared to control group from 38 at T1 to 21 at T2 (F=9.43, p=.0001). NS difference at T3 (24).</p> <p>Sleep disturbances (0-100, low-high number of disturbances): reduction in intervention group compared to control group from 30 at T1 to 20 at T2 (F=5.11, p=.007). NS difference at T3 (23).</p> <p>Appetite disturbances (0-100, low-high number of disturbances): reduction in intervention group compared to control group from 20 at T1 to 18 at T2 (F=3.96, p=.021). This remained at T3 (18).</p> <p>Neurovegetative complaints (0-100, low-high number of disturbances): increased T1 to T3 from 20 to 22 (f=3.54, p=.031)</p> <p>Gastrointestinal disorders: NS change.</p> <hr/> <p>Disturbance in social and family life (0-100, low-high number of disturbances): reduction in intervention group compared to control group on morning shift days from 39 at T1 to 28 at T2 and T3 (F=4.11, p=.018). NS differences on night or afternoon shift days.</p>
Ng-A-Tham & Thierry, 1993	<p>Sleep complaints (1-5, few - many complaints): decreased from 2.77 to 2.35 (t=3.33, df 42, p<.001).</p> <p>NS change: Fatigue, leisure time complaints.</p> <hr/> <p>Domestic and childcare problems(1-5, few - many complaints): decreased from 2.64 to 2.33 (t=2.63, df 44, p<.01)</p> <p>Weekly workload decreased (1-5, few - many complaints): from 2.64 to 2.10 (t=4.12, df 41, p<.001).</p> <p>Satisfaction with leisure time in the evening (1-10, not satisfied at all - very satisfied): increased from 5.8 to 6.4 (t=-2.63, df 45, p<.01).</p> <p>Satisfaction with days off (1-10, not satisfied at all - very satisfied): decreased from 7.1 to 5.8 (t=3.01, df 45, p<.001). Perhaps because the number of consecutive free days decreased.</p>
Williamson & Sanderson, 1986	<p>Decrease in % reporting sleep difficulties from 70% to 58% (x²=33.98, df=5, p<.001): initial difficulties falling asleep decreased from 87% to 67%,waking too early 61% to 12%, feeling unrefreshed after sleep 52% to 0%, feeling tired at work 61% to 0%, being irritable 67% to 0%. Being disturbed by noise increased from 26% to 33%.</p> <p>Sickness absence (3 month average pre, 3 month average post) fell from 6% to 4%.</p> <p>Decrease in overall illness rates (x²=28.32, df=7, p<.001): headaches 64% to 0%, digestive system disorders 46% to 4%, high blood pressure 21% to 12%, diarrhoea from 12% to 0%, constipation from 6% to 0%, Strait-trait anxiety inventory (Speilberger et al, 1970, 1-4, not at all - very much so): anxiety scores of over 90th percentile decreased from 6% to 0. Nervousness increased from 33% to 54%.</p> <p>NS change in levels of alcohol consumption, caffeine consumption or smoking.</p> <hr/> <p>Work pressure decreased from a score of 68 to 58 (t=4.02, df=57, p<.001).</p> <p>NS change in peer cohesion, job involvement, supervisor support, autonomy, task orientation, clarity, control, innovation or physical comfort.</p>

	<p>Job satisfaction (1-5, dissatisfied - satisfied) levels were higher with 50% reporting satisfied or somewhat satisfied at T2 compared to 36% at T1 ($\chi^2=12.18$, $df=4$, $p<.03$).</p>
DIRECTION OF ROTATION	
Orth-Gomer, 1983	<p>Coronary risk factors: triglycerides ($t=2.95$, $p=.005$) and serum glucose ($t=4.65$, $p<.001$) but not cholesterol levels ($t=1.33$, $p=.191$) were significantly lower during the intervention compared to the control condition. NS difference in serum uric acid levels.</p> <p>Mean systolic blood pressure was lower ($t=2.52$, $p<.05$) during intervention (111.6mg) compared to control condition (115.6mg). NS difference in diastolic.</p> <p>Duration (9hrs compared to 8.4hrs, $t=2.04$, $p<.05$) and quality of sleep (Akerstedt and Torsvall, 1981, 1-5.25 scale, low quality – high quality) at night after day work (3.7 compared to 3.2, $t=2.96$, $p<.01$) improved during the intervention compared to the control. NS differences in sleep duration of quality after night shift.</p> <p>Self-rated health status (1-5, higher = worse) worsened ($t=3.29$, $p<.01$) during intervention (1.84) compared to control (2.28).</p> <p>NS change in tobacco consumption.</p> <hr/> <p>NS difference work load and work strain</p> <p>Dissatisfaction with the amount of leisure time (1-5, higher = worse) between shifts decreased ($t=7.36$, $p<.001$) during intervention (1.44) compared to control (3.16).</p>
Barton et al, 1994	<p>Workers slept less well after the afternoon shift in the intervention group (Standard shift work index) compared to the control groups ($F=4.85$, $p<.05$). Difference for the morning or night shifts.</p> <p>Cigarette consumption decreased in the intervention group compared to the control groups (from 49.28 cigarettes per week to 38.8, $F=7.54$, $p<.01$).</p> <p>Alcohol consumption decreased in the intervention group compared to the control groups (from 10.59 drinks per week to 8.18, $F=6.99$, $p<.01$).</p> <p>NS differences for GHQ-12, chronic fatigue, gastrointestinal problems, sleep difficulties, sleep duration, sleep onset times.</p> <hr/> <p>Social disruption (Standard shift work index) decreased in the intervention group compared to the control groups (from 3.42 to 3.12, $F=6.18$, $p<.01$).</p> <p>NS differences for domestic disruption, non-domestic disruption, social life dissatisfaction.</p> <hr/> <p>NS difference job dissatisfaction.</p>
REMOVAL OF ROTATION	
Owen, 1985	<p>Trouble sleeping decreased in the intervention group compared to the control group (-0.41 and -0.2 respectively, $t=2.92$, $p<.025$).</p> <p>NS change: Trouble digesting, On the job tiredness, Appetite problems, Headaches, General health, Smoking, Drinking.</p> <hr/> <p>Satisfaction with opportunity to use abilities decreased less in the intervention group than the control group (-.21 and -.44 respectively, $t=1.73$, $p<.05$).</p> <p>Spousal satisfaction with shift schedule increased in the intervention group compared to the control group (.47 and .02 respectively, $t=2.19$, $p<.025$).</p> <p>NS difference in: Satisfaction with work load, Satisfaction with co-workers, Satisfaction with supervisors, Satisfaction with time spent with spouse, Satisfaction time spent with children, Time spent on social activities.</p>

	<p>Productivity (numbers of arrests and tickets issued) increased by 6% in the intervention group.</p> <p>NS change in job satisfaction</p>
Phillips et al, 1991	<p>Florida Sleep Questionnaire: officers required less sleep from 8.11 hours to 7.77 hours ($t=2.75$, $p<.01$) and they needed less sleep time to feel well from 7.30 to 7.01 hours ($t=2.18$, $p<.03$). Increase in adequacy ($t=-2.61$, $p<.01$) and quality of sleep (-2.20, $p<.03$). Officers felt more rested upon awakening ($t=2.94$, $p<.01$) and had less daytime sleepiness ($t=2.31$, $p<.02$). Awakening earlier than usual decreased ($t=2.31$, $p<.02$) and there was less difficulty falling asleep ($t=3.0$, $p<.001$).</p> <p>SCL-90 psychological symptoms checklist (0-4, no discomfort to extreme discomfort): decrease in number (19.25 to 15.18, $p<.05$) and severity of symptoms (0.282 to 0.214, $p<.05$).</p> <p>Sickness absence (6 months pre and post) decreased from 1400 hours to 883 hours.</p>
CHANGES TO NIGHT WORK	
Akerstadt & Torsvall, 1978	<p>Sleep/mood complaints improved in intervention compared to control: mean change = 0.3 ($p<.01$).</p> <p>Gastro-intestinal complaints improved in intervention compared to control: mean change = 0.2 ($p<.01$).</p> <p>NS changes in shift specific problems, sleep length, sickness absence.</p> <hr/> <p>Social complaints (time spent on clubs and hobbies, going out, political activity etc scored 4-1, enough to far too little) improved in intervention group compared to control: mean change 0.38 ($p<.01$).</p>
Smith & Mason, 2001	<p>Subjective fatigue (Standard Shiftwork Index): more fatigue on night shifts under the new system ($F7.99$, $p<.01$)</p> <p>Sleepiness (Standard Shiftwork Index): more sleepiness on the new system ($F7.93$, $p<.01$)</p> <p>NS decrease in caffeine intake.</p>
Kobayashi et al, 2004	<p>Sleep duration (minutes) before the night shift increased amongst both single nurses (from 146.6 to 232.2, $p<0.05$) and nurses who were married with children (from 127.0 to 187.2, $p<.05$).</p> <p>NS change in irritation and tiredness levels during night shift.</p>
LATER START & FINISH TIMES	
Rosa et al, 1996	<p>Sleep duration (hours) increased on the evening shift in intervention group, no change in control group ($F=11.27$, $p<.001$).</p> <p>Sleep quality (Standard shiftwork index, 1-5, very bad - very good): decrease in intervention group in evening shift (3.68 to 3.39, mean difference -0.29, $p<.05$) and night shift (2.89 to 2.63, mean difference -0.26, $p<.05$). NS change on morning shift or days off. NS changes in control group.</p> <p>Satisfaction with amount of sleep (Standard shiftwork index, 1-5, not enough – plenty): increase in intervention group in morning shift (2.74 to 3.31, mean difference 0.57, $p<.05$). Decrease on evening shift (4.07 to 3.63, mean difference -0.44, $p<.05$) and night shift (3.20 to 2.83, mean difference -0.37, $p<.05$). NS change in days off. NS changes in control group.</p> <p>Awaken refreshed from sleep (Standard shiftwork index, 1-5, not at all – extremely): increase in intervention group in morning shift (2.65 to 3.15, mean difference 0.50, $p<.05$). Decrease on evening shift (3.89 to 3.60, mean difference -0.29, $p<.05$) and night shift (2.8 to 2.51, mean difference -0.29, $p<.05$). NS change in days off. NS changes in control group.</p> <p>NS changes in health complaints or chronic fatigue.</p> <hr/> <p>Interference of shift work with domestic activities increased in intervention group but not in control group ($F=5.54$, $p<.03$).</p> <p>NS changes in Mental and physical workload</p>

	NS changes in Job satisfaction
CHANGES TO WEEKEND WORKING	
Boggild & Jeppesen, 2001	Group B compared to control: Increase in HDL cholesterol (median change of 0.1 mmol/l, p=.004), decrease in total (median change of -0.1 mmol/l, p=.043) and LDL cholesterol (median change of -0.2 mmol/l, p=.005), decrease in total:HDL ratio (median change of -0.3 mmol/l, p=.000). Changes in total:HDL ratio and LDL cholesterol were still significant when data were adjusted for age and lifestyle.
	NS changes in Group A.
Banks, 1956	38% of wives said that the change had most negatively affected their social life (going out, visits to friends and family, hobbies and clubs), 11% their domestic routine (meal preparation, washing etc), and 10% time with their husband. 25% reported no detrimental effect as a result of the change and 11% said that social and domestic life had improved. NS difference in responses by household size or number of dependents.
DECREASED HOURS	
Boudreaux et al, 1998	Emotional exhaustion (Maslach Burnout Inventory, 0-6 never to everyday, higher scores represent more burnout) decreased at 2 month follow up from 23.6 to 19.8 (t=3.06, p<.01). NS change between baseline and 12 month follow up.
	Schedule impact on social and family life (schedule attitude survey, 1-5, strongly agree to strongly disagree, higher scores represent less interference) improved at 2 month (7.2 to 10.8, t=-4.52, p<.001) and 12 month follow ups (10.9, t=-5.0).
	NS change in depersonalisation.
	NS change job satisfaction.
Best, 1933	25.2% reported less fatigue, 56.1% the same amount of fatigue and 18.7% more fatigue.
	64.7% reported no inconvenience or upset to domestic arrangements
	Due to the decrease in working hours, earnings of 77% of workforce decreased by 10-20% despite an increase in hourly pay.
SELF-SCHEDULING	
De Haan, 1990	Sickness absence rates decreased in the intervention group from an average of 28 days per driver to 20 days. Rates increased in the control group from 32 to 47 days.
	Fatigue (0=minimum, 11=maximum) decreased in intervention group (from 3.31 to 1.94, p<.05). NS decrease in control group (3.57 to 3.09, p>.05).
	Complaints about family life (1=very good, 5= very bad) decreased in intervention group (from 2.77 to 2.11, p<.05). NS decrease in control group (from 2.52 to 2.40).
	Support from manager (1=very good, 5= very bad) improved in the intervention group (from 3.06 to 2.50, p<.01). NS deterioration in control group (from 2.89 to 3.00).
	NS change in complaints about free time or time with children.
	Productive work hours increased from 50% to over 54% in the intervention group. No data for the control group.
Gauderer & Knauth, 200	Accidents decreased by 20%
	79% said that the new rotas gave better opportunities to plan their leisure time.

	<p>66.6% said that the new system was better for social contacts.</p> <hr/> <p>Customer complaints by 52% in intervention group whilst there were slight increases for both measures in the control group.</p>
Wortley & Grierson-Hill, 2003	21% said that they were rarely or never able to maintain a work/life balance under the old system compared to 0% after the change.
MULTIPLE	
Akerstadt & Torsvall, 1978	<p>Shift specific problems (difficulty in falling asleep, disturbed sleep, waking up too soon, slept well, fatigue, irritation, good appetite, gastrointestinal complaints, scored 4-1, never to often) increased on all shifts: mean change morning -0.2, afternoon -0.18, night -0.18 (p<.05).</p> <p>Sleep length (hours): decreased on rest days (0.4, p<.05). NS change on morning, afternoon or night shift days.</p> <p>NS changes in sleep/mood complaints, gastro-intestinal complaints, sickness absence.</p> <p>Social complaints (time spent on clubs and hobbies, going out, political activity etc scored 4-1, enough to far too little) improved in intervention group compared to control: mean change 0.18 (p<.01).</p>
Poole et al, 1982	<p>Increase in percentage reporting difficulties in 'getting up for work' (from 39% to 50%, p<.05).</p> <p>Decrease in percentage reporting 'feeling sleepy on the night shift during previous month' (from 73% to 64%, p<.05).</p> <p>Increase in percentage reporting indigestion problems in previous week (from 22% to 35%, p<.05).</p> <p>Stress and Arousal Checklist (Mackay et al, 1978): deterioration in 'arousal' scores (from 6.9 to 6.3, p<.05). NS change in 'stress'. NS change in anxiety or depression. NS change in 'felt stressed'.</p> <p>Alcohol consumption in previous week (units of alcohol) increased from 12.0 units to 13.4 units (p<.05).</p> <p>NS change in reported abdominal pain, heartburn, or bowel movements.</p> <p>NS change in 'difficulty going to sleep'</p> <p>NS change in number of visits to doctor in previous month.</p> <p>NS change in sickness absence 10 weeks average pre compared to post.</p> <hr/> <p>Enjoyment of social life and sex life (0-7, bad-good) decreased (from 5.0 to 4.5, p<.05 and 4.8 to 4.3, p<.05 respectively).</p> <p>NS change in 'tension at home'.</p> <hr/> <p>NS change 'Enjoyment of work'.</p>
Bodin, 1983	<p>Percentage of workers reporting tiredness in intervention group decreased from 34.4% to 30.8%. There was an increase in the control group from 21.6% to 41%.</p> <p>Percentage of workers reporting lack of appetite in intervention group decreased from 35.4% to 24%. There was an increase in the control group from 10.8% to 20%.</p> <p>Percentage of workers reporting digestive disorders in intervention group decreased from 35.4% to 26%. There was no change in the control group (23.5%).</p> <p>Percentage of workers reporting nervous disorders decreased in both the intervention (from 51.9% to 48.4%) and the control groups (from 44% to 8.4%).</p> <p>Percentage of workers reporting incidences of physical stiffness increased in both the intervention (from 21.1% to 51%) and the control groups (from</p>

	<p>18.9% to 44%).</p> <p>Effects of change on family life rated as positive by 65% of workers on the slow rotation and 58% on the fast rotation. 49% of all workers said that they had more time to take part in family life. 39% of fast rotation workers stated that they had more time to enjoy their customary activities compared to 71% on the slow rotation.</p>
Knauth & Kiesswetter, 1987	<p>Sleep difficulties during night shifts decreased in the intervention group compared to the control group ($p < .01$). NS decrease in afternoon shifts ($p = .079$).</p> <p>NS change in sleep duration. NS change in gastrointestinal symptoms.</p> <hr/> <p>18/31 (58%) earned less on the new system due to decline in overtime.</p>
Kandolin & Huida, 1996	<p>Standard shiftwork index (Barton et al, 1992) and Occupational Stress Questionnaire (Elo et al 1992): ns difference in 'mental strain during morning shift' between intervention and control group (27% to 11% intervention group stating rather or very strenuous); ns difference in mental strain during evening shift (17% to 9% rather or very strenuous) between intervention and control group.</p> <p>Decrease in tiredness during night shift (53% to 44% rather or very tired)</p> <p>NS difference in mental stress (27% to 15% in intervention group somewhat or much).</p> <p>Intervention group: 'good possibilities to participate in planning own schedule' increased from 27% to 42% ($p = 0.03$)</p>
Czeisler et al, 1982	<p>Health index scores (Smith et al 1969, 0-100, low-high) improved in intervention group B (from 50 to 60%, $t = 3.23$, $p < .01$). NS change in group A.</p> <hr/> <p>Productivity (tonnes processed per hour) increased in intervention group B (from 0.9 to 1.05, $t = 6.99$, $p < .001$). No data for group A.</p>
Totterdell & Folkard, 1990	<p>NS difference total duration of sleep or average sleep quality.</p> <p>In both groups, time for social activities improved ($F = 4.48$; $df = 1, 20$; $p < .05$) but communication with colleagues decreased ($F = 7.37$; $df = 1, 20$; $p < .05$).</p> <p>Disruption to personal life ($F = 4.67$, $df = 1, 20$; $p < .05$); time for social activities ($F = 9.56$; $df = 1, 20$; $p < .05$) and difficulty of planning social life ($F = 10.17$; $df = 1, 20$; $p < .05$) all deteriorated in A (flexible) and improved in B (standard).</p> <p>NS change in 25 other unspecified well-being and satisfaction variables.</p>
Hakola & Harma, 2001	<p>Standard Shiftwork Index (1-5, never – always): NS changes on evening and night shift days. On morning shift days, 'feels rested' improved (0.8 to 2.6, $p = .008$), 'quality of sleep' improved (2.1 to 2.7, $p < .05$), sufficient amount of sleep improved (2.1 to 2.9, $p < .003$). NS changes on morning shift days for 'easy to fall asleep', 'wakes up when intended'.</p> <p>Overall quality of sleep improved ($F = 8.48$, $p < .013$) for older workers (mean age 54 years) compared to younger workers (mean age 39 years).</p>
Knauth & Hornberger, 1998	<p>NS change in health, sleep duration, sleep disturbances.</p> <hr/> <p>Frequency of difficulties with social problems (Knauth & Kiesswetter, 1987, 0-100 scales, no –always) decreased on days with evening shifts on new system A (from 38 to 30, $p < .05$) and on morning (from 40 to 21, $p < .05$), evening (from 42 to 26, $p < .05$) and afternoon (from 43 to 22, $p < .05$) shift days in new system B.</p> <p>NS change in duration of leisure time.</p>

^ASpecific scales and measures used are also recorded when cited in studies. Similarly, statistical detail varies depending on the amount of information available in the original studies.

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