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Complete List of Authors:	Voglino, Gianluca; University of Turin, Department of Public Health Savatteri, Armando; University of Turin, Department of Public Health and Paediatric Sciences Gualano, Maria; University of Turin, Department of Public Health and Paediatric Sciences Catozzi, Dario; University of Turin, Department of Public Health Rousset, Stefano; University of Turin, Department of Public Health and Paediatric Sciences Boietti, Edoardo; University of Turin, Department of Public Health and Paediatric Sciences Bert, Fabrizio; University of Turin, Department of Public Health; University Hospital City of Science and Health Turin Siliquini, Roberta; Università degli Studi di Torino, Department of Public Health
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Title page

Title:
How the reduction of working hours could influence health outcomes: a review of published studies

Authors:
Gianluca Voglino[1], Armando Savatteri[1], Maria Rosaria Gualano[1], Dario Catozzi[1], Stefano Rousset[1], Edoardo Boietti[1], Fabrizio Bert[1], Roberta Siliquini[1,2]

[1]Department of Public Health and Paediatric Sciences, University of Turin, Torino, Italy.
[2]A.O.U. City of Health and Science of Turin, Turin, Italy.

Corresponding author:
Maria Rosaria Gualano, Via Santena 5 bis, 10126, Turin, Italy
Email: mariarosaria.gualano@unito.it

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ABSTRACT

Objectives

The health effects of worktime arrangements have been largely studied for long working hours, whereas a lack of knowledge remains regarding the potential health impact of reduced worktime interventions. Therefore, we conducted this review in order to assess the relationships between worktime reduction and health.

Methods

Our review followed the PRISMA statement. We considered papers exploring the relationship between worktime reduction with preserved salary and several health outcomes.

Results

We selected 7 studies, all with a longitudinal design. Results showed a positive relationship between reduced work hours and working life quality, sleep, stress and certain general symptoms, such as cardiovascular and musculoskeletal ones.

Conclusions

Taken together these findings suggest that reducing worktime while retaining salary is a promising workplace intervention that should be taken into consideration to improve employees' well-being.

Keywords: working hours; well-being; reducing worktime; working life quality

Strenghts and limitations of this study

- This review identified a positive relationship between reduced work hours with preserved salary and without an increase in total workload and working life quality, sleep, stress and some general symptoms.
- These findings could encourage companies and policy makers to reduce working hours and preserve workers' health.
- Due to scarcity of studies investigating the reduction of work hours, only few relevant studies were found and some of the review findings were inconclusive
- The current state of the art in how individuals would benefit from work hours reduction is still poor and further studies are needed to address this issue, especially if such work arrangement keeps employees' productivity unchanged for a possible reduction in sick days.

INTRODUCTION

In Organization for Economic Cooperation and Development (OECD) countries the average working week consists of 37 hours[1]. OECD Data on annual average working hours show that, despite a declining trend in the amount of worked hours, many Countries still exceed the standard[2]. Working long hours is widely recognized as detrimental for employees' health. Indeed, several studies investigating the health effects of working overtime reported concerning findings, including increased risk of stroke, coronary heart disease, anxiety, depression, sleep disorders and adverse pregnancy outcomes in women [3–5]. Furthermore, a systematic assessment of evidence in literature with meta-analyses conducted by Rivera et al. found moderate-grade evidence linking long work-hours with stroke and low-grade evidence on the association between

long work-hours with coronary disease, depression and pregnancy complications, including low birth weight babies and preterm delivery[6]. Long working hours have also been associated with reduced levels of work-life balance and increased work-family conflict[7].

Conversely, the effects of reduced work-hours have not been extensively examined as for long work-hours so far. Indeed, several experiments of reducing working time have been conducted throughout the years, both in the public and private sector. One of the most notable examples was the adoption of the "35-hour Workweek" between 1998 and 2000 by the French Government, which allowed the reduction of weekly working hours from 39 to 35, with the aim of fighting the high unemployment rates. However, aside from two surveys examining employees' satisfaction with modified work-hours and their work-family conflict, no other impacts on health and well-being have been evaluated [8,9]. The authors argue that the French 35-hours law increased overall dissatisfaction with modified work hours among employees, mainly because it did not take into account the heterogeneity of work organization. It appears that employees increased workload to maintain high productivity. Indeed, reducing working time without employing extra-personnel may compromise the fine balance between job demand and resources, which in turn would undermine employees' wellbeing[10]. Further interventions have been carried out on a company level. In Germany, Volkswagen reduced the working week from 36 to 28.8 hours[11] and more recently, Microsoft Japan tested a four-days work week [12]. Similarly, Perpetual Guardian, a New Zealand firm operating in the management of trusts, wills and estates, ran a four-day work week trial for all its 240 employees [13]. Although companies reported successful results, they did not take into consideration the potential health impact of these experiences.

Besides, there are few studies even in scientific literature that investigate the role of reduced work hours on workers' health. To our knowledge, only one literature review was conducted in 2005 and authors concluded that no relevant effects on health were observed [14]. However, the review was published in Swedish, hence it may represent an issue due to language barriers. Furthermore, the studies included in their work were mostly reports from Swedish ministerial committees and critical reviews on work time arrangements. Indeed, in the studies published before 2000 authors were primarily interested in the economic consequences of reducing work-hours, exploring the feasibility of the project, and little attention was paid to the effects of worktime reduction on the health of employees. Since 2000, several interventional studies have been published. Therefore, we decided to conduct a review of the literature examining studies focusing on the relationship between reduced working hours and health effects, published since 2000, in which employees retained their salary and proportionally decreased their work time and workload.

METHODS

Search strategy

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist we carried out a literature search for articles published in Medline, PsycInfo, Embase and Web of Science databases from January 2000 up to November 2019. Search terms included terms like "work", "health", "well-being", "mental-health", "worktime reduction", "reduced work hours". Full search strings for each database are provided in supplemental file 1. First, duplicates were excluded. Next, AS, DC, EB and GV independently screened retrieved sources by title and abstract following inclusion criteria. The same authors, always in an independent fashion, performed a full text review. Finally, consensus was reached through discussion about uncertain cases between all reviewers. Authors chose Rayyan QCRI as a tool for selecting and extracting relevant[15].

Inclusion and exclusion criteria

We decided to include primary sources in any form, both interventional and observational studies, provided that quantitative analysis of any health-related outcome were performed. Hence, studies with qualitative research methods were excluded because we were interested on the effects of the interventions in terms of quantitatively measured outcomes. Articles had to investigate the association between reduced working time with retained salary and health effects, without excluding beforehand any category of workers. No salary reduction was considered crucial in order to avoid a selection bias possibly leading to exclude low-income workers. Another inclusion criterion was the replacement of working activity with any workplace-based intervention, provided that the amount of work hours was effectively reduced. Conversely, studies specifically focused on worktime reduction policies regarding activities with excessively long working hours, such as medical residency, were not consistent with the concept of reduced working hours and retained salary and were therefore excluded from our work. No language restriction was set. Due to the heterogeneity in the outcomes evaluated by the studies selected, a meta-analysis of data could not be conducted. Data and information regarding study design, Country, participant characteristics, observation period, intervention description, outcomes measured and results were extracted and synthesised in a literature review.

Patient and Public Involvement

No patients were involved in this study.

RESULTS

As results of the bibliographic search, a total of 3876 published articles were identified (**Figure 1**).

Figure 1 Systematic review: selection process. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta- Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

Duplicates were excluded and remaining 2456 records were reviewed. A full-text review was conducted on 40 articles. Finally, after evaluating the inclusion criteria, 7 articles were selected (1 article was originally added by citation chasing). In Total 7 articles, with a longitudinal interventional design, were included in the final analysis[18–24]. A brief summary of included articles is provided in **Table 1.**

Table 1 Characteristics of the studies included in systematic review.

Author	Study Design	Country & Participants	Observation period	Intervention description	Outcome (measures)	Results
Akersredt et al, 2001	Longitudinal intervention study	Sweden, N = 63, full-time workers in health care service.	36 Months	Intervention group (N=41): reduced WWH from 39 hrs/week to 30 hrs/week. Control group (N=22): unchanged working time.	General symptoms, neuro-psychological symptoms, working life quality, quality of life, physical activity and sleep.	Subjective sleep quality (SSQ), mental fatigue and heart/respiratory symptoms, time for social activity, time for family and friends improved significantly more in the experimental group than in the control group. No significant effects at all for sickness absence or for self-rated health.
Wergeland et al, 2003	Longitudinal intervention study	Norway and Sweden, N = 403. Workers in nursing homes, institution covering home care services and kindergartens	12-22 Months	Intervention group: reduced DWH to 6 hrs/day. Reference group: unchanged working time.	Musculoskeletal disorders and working life quality (shoulder-neck and back pain frequency and work-related physical exhaustion)	A significant interaction was found for neck-shoulder pain and for exhaustion after work 1 year after the work-hour reduction in the intervention group. No significant effects were observed in the reference group.
von Thiele et al, 2008	Longitudinal intervention study	Sweden, N = 177 employees from 6 workplaces at a public dental health care organization	12 Months	PE group: 2.5 hrs/week of physical activity instead of work time. Reduced work hours group: reduced WWH proportionally to the amount of time worked. Reference group: unchanged working time.	General symptoms, musculoskeletal disorders, working life quality (work-home interference, recovery from work and work ability), physical activity (overall physical activity and physical exercise) and biological markers (blood lipids, neuroendocrine markers, metabolic and cardiovascular measures)	Physical activity increased in all three groups. Decreased glucose and upper-extremity disorders were found in the exercise group, while increased HDL and waist-to-hip ratio was found among those working reduced hours. Participants working reduced hours

						also had increased total cholesterol and no changes in LDL-to-HDL ratio.
von Thiele et al, 2011	Longitudinal intervention study	Sweden, N = 177 employees from 6 workplaces at a public dental health care organization	12 Months	PE group: 2.5 hrs/week of physical activity instead of work time. Reduced work hours group: reduced WWH proportionally to the amount of time worked. Reference group: unchanged working time.	On-the-job productivity, working life quality (sickness presenteeism and sickness absenteeism) Objective production levels (administrative records)	Physical activity was associated with an increase in self-rated productivity in terms of increased quantity of work and work-ability and decreased frequency and number of days of sickness absence. No effect was found in the work hours reduction group. In all three groups there was an increase in the number of treated patients per therapist, significantly greater in the reduced work hours group.
Barck-Holst et al, 2017	Longitudinal quasi-experimental trial	Sweden, N= 204 A total of 125 participants were deemed as per protocol.	18 Months	Intervention group: reduced work hours by 25%. Reference group: unchanged working time.	Neuro-psychological symptoms (exhaustion syndrome, average stress level; stress, memory difficulties; negative emotion, fatigue and exhaustion), working life quality (demands, control, social support, instrumental manager support, instrumental coworker support, work intrusion on private life, private life intrusion on work) and sleep (restorative sleep, sleep quality and adequate sleep length)	Overall, the intervention group significantly improved restorative sleep, stress, memory difficulties, negative emotion, sleepiness, fatigue and exhaustion on both work days and weekends; sleep quality was improved on weekends. Moreover, improved demands, instrumental manager support and work intrusion on private life were observed in the intervention group.

Lorentzon 2017	Longitudinal intervention study	Sweden, N = 124, nurses working in a centre for the elderly	23 Months	Intervention group: work-time reduction to 6 hrs/ day. Reference group: unchanged working time.	General symptoms, musculoskeletal disorders (perceived health and eating habits), neuro-psychological symptoms (alertness level, perceived fatigue, energy left at home, feeling calm, perceived stress), working life quality (occupational health, collaboration and personal development between colleagues, sick leaves), physical activity (physical activity levels), sleep (average sleep time and sleep quality)	Health perceived as good (72% vs 60%), alertness level perceived as good (65% vs 50%), satisfactory level of perceived fatigue (+20% vs -22%), feeling having a lot of energy left when arriving at home (51% vs 7%,), feeling calm (64% vs 45%), satisfactory levels of stress (+20%, -5%), average sleep time (7 hours in intervention group, 5.8 hours in control group). Satisfaction regarding physical activity increased. Healthy eating habits were virtually unchanged; general symptoms, sleep and symptoms affecting the musculoskeletal system improved in the intervention group, and dropped in the control group. Collaboration and personal development improved; improved sense of collaboration between nurses. Sick leave increased in the intervention group.
Schiller et al, 2017	Longitudinal controlled intervention study	Sweden, N=580, workers from 33 workplaces in the public sector	18 Months	Intervention group: reduced WWH by 25%. Reference group: unchanged working time.	Sleep, perceived stress and worries	On workdays, the intervention group displayed improved SSQ, 23 minutes extended sleep duration, decreased sleepiness and perceived stress and less feelings of worries and stress at bedtime when work hours were reduced. Similarly, the intervention showed positive

						effects on days off, except for sleep duration.

The included studies were published between 2001[24]and 2017[18,19,23] and they were performed in northern Europe[18–24]. The sample size ranged from 63 participants [24] to 580 workers [19], mostly from healthcare settings[20–24]. Only one of the included studies enrolled workers from different workplaces in the public sector (Schiller et al. 2017). All the studies included had a longitudinal design and the observation period was between 12 months [20–22] and 23 months [23]. Although all the studies compared the intervention group to a control group with no work-time modifications, the intervention exanimated were different. In particular, two studies assessed a work-time reduction to 6 hours per day [22,23], two studies evaluated a weekly work-time reduction of 25% [18,19], two studies evaluated simultaneously a reduced weekly work-time reduction proportionally to the amount of time worked (reduced work hours group) and a 2.5 hours per week physical activity instead of work time program (physical exercise group) [20,21] and one study assessed a reduced weekly work-time reduction from 39 to 30 hours per week [24]. The included studies assessed a variety of different outcomes. In particular general symptoms [20,23,24], neuro-psychological symptoms [18,23,24], working life quality [18,20–24], quality of life [18,23,24], physical activity [20,23,24], sleep [18,19,23,24], musculoskeletal disorders [20,22,23] and biological markers [20] were assessed.
In particular, Åkerstedt and colleagues performed a longitudinal cohort study in 5 different healthcare settings, in order to compare the effects of work-hours reduction among health care and day care nursery personnel. The study involved a total of 63 nurses, 41 in the experimental group, a 9 hours reduction of the working week from 39 hours per week to 30 hours, retaining full pay, and 22 in the control group. The experimental group showed a significant improvement for heart/respiratory symptoms, mental fatigue, sleep quality, time for social, time for family/friends, influence on work-hours and satisfaction with work-hours, Additionally, most of these variables also showed a significant change over time. Furthermore, there was a positive change over time for pain/ache complaints, nervous symptoms, gastrointestinal complaints, insomnia complaints, refreshed at awakening, sleepiness at work/leisure time, involuntary sleep at work and leisure time and satisfaction with the work situation. On the contrary, no significant interaction was found between reduced work hours and exercise, weight and BMI[24].
Similar results were published by Barck-Holst and colleagues. They performed a longitudinal quasi experimental study involving seven public social service agencies. Employees in the intervention group reduced their work hours by 25% but retained their previous salary and their organizations were fully reimbursed and staff to compensate the loss of work hours was hired. After controlling for baseline values, gender and age, there was a significant difference in change over time between intervention and control group during workdays on the restorative sleep index, average stress level, the stress index, the memory difficulties index, the negative emotion index, average sleepiness and the fatigue and exhaustion index[18].
In addition, a longitudinal controlled intervention study evaluating a 25% reduction of weekly work hours was published in 2017 by Schiller and colleagues. In this paper, participants worked at 33 different workplaces, in four sectors: social services (n=170); technical services (n=236); care and welfare (n=159); call-centre (n=71). The intervention group (n=370) reduced work-time to 75% with preserved salary during 18 months. Data were collected at baseline (1–2 months before the intervention) and approximately 9 months and 18 months after the introduction of reduced work hours. On workdays, the intervention group (N=354) displayed improved subjective sleep quality, 23 minutes extended sleep duration (over the whole period of 18 months), decreased sleepiness and perceived stress and less feelings of worries and stress at bedtime when work hours were reduced (P<0.002). Gender, age, having children living at home, and baseline values of sleep quality and worries and stress at bedtime, considered as additional between-group factors, did not influence the results significantly [19].
Similar outcomes were assessed in a cohort study, performed between February 2015 and December 2016. In this paper, 68 nurses from the intervention group had their working time reduced to 6 hours per day with retaining their full-time pay. On the contrary, nurses in the control group (N=56) had no working hours reduction. Outcomes were assessed using several questionnaires before, during and after the experimentation. In particular, the sick leave was 6.1% in the intervention group and 12.3% in the control group. Furthermore, health perceived as good (72% vs 60%), alertness level perceived as good (65% vs 50%), satisfactory level of perceived fatigue (+20% vs -22%), feeling having a lot of energy left when arriving at home (51% vs 7%, both starting from 20%), feeling calm (64% vs 45%), satisfactory levels of stress (+20%, -5%), average sleep time (7 hours vs 5.8 hours) had better values in the intervention group compared to the control group. Additionally, in the intervention group, satisfaction regarding physical activity increased (+ 7% vs -15%). Finally, general symptoms, sleep and symptoms affecting the musculoskeletal system improved in the intervention group, and dropped for the control group [23].
Similarly, a previous paper assessing the occurrence of musculoskeletal disorders in the experimental and control groups was published by Wegerland and colleagues. In their longitudinal intervention study, involving subjects enrolled from different institutions, workers in the experimental group had their daily work-hours reduced to 6 hours, with retained salary and extra personnel employed to compensate for the reduction in work-hours. Participants were involved through a self-administered questionnaire about pain in the neck-shoulder and back regions prior to and during the work-time reduction. By using a multivariable analysis on data from all the institutions, authors found a significant interaction for

neck-shoulder pain (p=0.034) and exhaustion after work (P=0.009). No significant interaction was found for back pain. Additionally, the intervention group showed increased job satisfaction after the reduction in work-hours [22].

Finally, von Thiele and colleagues performed two longitudinal studies in Stockholm, Sweden, involving employees from six workplaces in a large public dental health care organization, randomly allocated to one of three groups: physical-exercise group (PE), reduced work-hours group (RWH), and reference group (R). At the two workplaces acting as reference, no intervention was carried out; at the two workplaces in the PE group, 2.5 hours of weekly work hours were allocated to mandatory physical exercise on two different days; at the two workplaces in the RWH group, full-time weekly hours were reduced from 40 hours/week to 37.5 hours/week. All employees in the intervention groups retained their salaries, and no additional personnel were employed. The final sample consisted of 177 employees, mainly women. Participants were instructed to complete self-ratings at baseline, after 6 months and after 12 months [20,21].

In the paper published in 2008[20] blood samples were and questionnaire were used to explore the areas of physical activity, recovery from work stress, work-home interference, self-related health, work ability, general and musculoskeletal symptoms. The results showed a significant increase in physical exercise in all three groups over time, with post-hoc tests showed that the increase in the PE group was significantly greater than in the other two groups. Additionally, the analysis showed increasing levels of all of the blood lipids in the reference group (p<0.001, for total cholesterol; p=0.016, for triglycerides; p=0.003, for HDL; p<0.001, for LDL). In the RWH group, total cholesterol and HDL had increased significantly (p=0.019, for total cholesterol; p=0.016, for HDL), while only total cholesterol had increased significantly in the physical-exercise group (p=0.018). Glucose showed a significant time × group effect (p=0.04), and a significant decrease in the PE group (p=0.036). Work ability decreased in the reference group (p=0.005); similar results were found for general symptoms [20].

In the paper published in 2011[21], three outcomes were measured: on-the-job productivity, measured with a single item asking the respondents to rate their current work ability as compared with their individual best work ability on a ten-point scale; sickness presenteeism and sickness absenteeism, assessed with three questions; objective production levels, in terms of the number of treated patients and the number of therapists per month for each participating worksite as well as for all worksites combined. The results showed a significant increase in self-rated quantity of work (p = 0.029) and work ability (p = 0.046) in the PE group. Work ability decreased significantly in the reference group (p = 0.004). In the PE group, frequency of sickness absence (p = 0.037) and sickness duration (p = 0.029) decreased significantly. In the reference group changes in sickness absence duration (p = 0.041) and sickness presenteeism (p=0.028) were each significant [21].

Quality assessment

The quality of the included studies was assessed using the "Quality Assessment Tool for Quantitative Studies" developed by the Effective Public Health Practice Project (EPHPP)[16]. This quality appraisal tool provides a standardized means to assess study quality and develop recommendations for study findings considering eight components of study methodology: selection bias, study design, presence of confounders, blinding of participants and outcome assessors, validity and reliability of data collection methods and study dropouts and withdrawals. The overall quality of each study is then expressed as weak, moderate or strong. Previous evaluation of the tool has shown it to be valid and reliable[17]. Two reviewers, namely AS and SR, independently performed quality assessment. Discrepancies between the reviewers, such as differences in interpretation of criteria and studies, were resolved by discussion in order to reach consensus. The overall quality was found to be strong for three studies, moderate for one study and weak for three studies.

DISCUSSION

The purpose of this review was to analyze the results of studies conducted in order to explore the consequences of work time reduction on health outcomes, which is an emerging and debated issue especially in western countries with a developed welfare system, as the ones in Northern Europe. We analysed 7 published articles exploring several different outcomes, and all of them were investigated and discussed.

General and physical symptoms

Four longitudinal studies analysed the relationship between work-time reduction and a broad spectrum of general and physical symptoms. Åkerstedt et al.[24] found a significant improvement of hearth/respiratory symptoms in the experimental group compared to the control group. However, when self-rated health was explored as an outcome, they did not find any statistically significant differences before and after the intervention, neither between the experimental and the control group, nor over time among the same group. Similar results were obtained by von Thiele et al., which did not find any significant differences between the intervention and the reference group regarding neither general symptoms nor self-rated health [20]. As the Authors suggest, the lack of significant results could be explained by the fact that the study was carried out on healthy subjects, consequently reducing the effect size, especially for self-ratings. On the other hand, Lorentzon et al. found an improvement in perceived health in the intervention group compared to the control group[23]. Wergeland et al., in their three-project study, found a significant reduction of neck/shoulder and back pain prevalence in the intervention group[22], in agreement with Lorentzon et al. [23], possibly due to a reduction of time spent in the sitting position during work-time.

Data are still contradictory and it is possible to hypothesize that the real impact of workload reduction on general and physical symptoms, despite having a possible effect on specific physical symptoms, remains to be determined through further larger studies.

Neuro-psychological symptoms

Four studies evaluated the relationship between work-time reduction and neuro-psychological symptoms [18,19,23,24]. General stress was the most frequently explored outcome. Barck-Holst et al. found an average stress level and a stress index significantly decreased in the intervention group, but this difference was higher on workdays compared to weekends [18]. This is consistent with the results of Schiller et al., who found a significant reduction of stress both during the day and at bedtime in the intervention group [19]. Lorentzon et al. found that workers with reduced work-time reported satisfactory levels of stress and perceived fatigue more often in comparison with workers in the control group [23]. Åkerstedt et al. found a significant reduction of mental fatigue in the experimental group. In addition, they found a reduction of nervous symptoms and pain/ache complaints over time, but this difference was not significant between the experimental and the control group. As the authors suggest, the project in itself may have increased the awareness of work organization and health, with positive effects on both groups [24].

Globally, these results suggest that the reduction of work-time is associated with a significant improvement of stress and other neuro-psychological symptoms, probably due to the decrease of workload and the consequent increase of free time for leisure activities.

Sleep

Sleep condition was evaluated in five studies[18–20,23,24]. Åkerstedt et al. and Schiller et al. measured subjective sleep quality (SSQ) using the same items and improvements were observed significantly more in the intervention group than in the reference group[19,24]. Similar results were reported by Barck-Holst et al.[18]. In their study on nurses, Lorentzon et al. found that those nurses working less hours as a part of the experiment averagely slept more than nurses who kept working with regular hours[23]. von Tiele et al. evaluated the presence of sleep disturbances as part of a more comprehensive questionnaire - a modified version of QPSNordic - investigating general symptoms[20,25]. Although they found no improvements in the experimental group regarding general symptoms, we cannot tell whether the occurrence of sleep disturbances taken alone differed among their participants. Despite different measurements being adopted, almost all studies found a significant improvement in sleep among intervention groups compared to control groups. As already reported by previous research, long working hours have shown to negatively influence sleep in many ways [26,27] and this effect may be explained by higher work demands and work-related stress [28]. Thus, we hypothesize that the positive effects of reduced work-time on stress and workload may explain the positive effects on sleep.

Quality of working life

All studies except one investigated whether reduced work hours had measurable effects on working life quality[18–20,22–24]. Åkerstedt et al. found no effects on work demands, but workload had decreased for both intervention and control group. As hypothesized by the authors, it is possible that an increased awareness of work organization following the experiment may be the cause of such findings[24]. No effects on sickness absence were found, as opposed to von Tiele et al., where employees in the intervention group decreased frequency and number of days of sickness absence, as well as perceiving improved self-rated work ability[20]. Other work-related factors were reported as significantly improved after the experiment, including exhaustion after work, sense of collaboration between colleagues, demands, instrumental manager support and work intrusion on private life [18,22,23]. The last finding is in line with results from Anntila et al., in which shorter working hours were associated with positive work-family interaction[29]. Overall, reduced working hours seem to improve working-life quality.

Quality of life

Three studies evaluated the effect of work-time reduction on quality of life outside of work[20,23,24]. Åkerstedt et al. found a significant increase in time for family/friends and social activities in the experimental group, and this increase was significant also over time among the experimental group [24]. However, as mentioned above, they did not find any improvement in the self-rated health. It is possible that the extra free time, despite exerting a positive effect on general quality of life, does not necessarily determine an improvement in self-perceived health. These results are consistent with the results of von Thiele et al., who did not find any significant differences regarding work-time interaction, neither between the intervention groups and the reference group nor over time among the same groups [20]. In addition, Lorentzon et al. found that healthy behaviours, such as healthy eating, did not improve in the intervention group [23]. Overall, these results suggest that work time reduction per se is not necessarily associated with an improvement in the balance between work and private life. Hence, beside work-time reduction, it is also important to focus on how the extra free time is spent, in order to make the reduction in work-time and workload really effective in exerting positive effects on individual health.

Physical activity

Physical activity was evaluated by three studies[20,23,24]. While Åkerstedt et al. found no significant improvements regarding physical exercise[24], von Thiele et al and Lorentzon et al observed an increase in physical activity in participants experimenting reduced work hours[20,23]. However, the study design by von Thiele et al. consisted in three groups (physical activity group, reduced work hours group and reference group) and such increases were observed in all of them[20]. We do not know whether these changes were a consequence of an increased awareness towards physical exercise brought by the experiment. Moreover, the number of studies evaluating this specific outcome are too few. Although previous research has shown that there seems to be an inverse association between work hours and physical activity [30], for the reasons listed above it cannot be concluded that reduced work hours are associated with increased levels of physical activity. Indeed, we do not know whether employees working for reduced work time would engage their spare time into physical exercise. Hence, more experiments are needed to better determine this subject.

Biological markers

Only von Thiele et al. evaluated the effect of work-time reduction on several biological markers[20]. They found in the reference group increasing levels of all of the blood lipids. In the reduced work hours group, total cholesterol and HDL had increased significantly, while only total cholesterol had increased significantly in the physical-exercise group. Regarding metabolic measures, glucose showed a significant decrease in the physical-exercise group only, while the waist-to-hip ratio increased in the reduced work hours group. These last findings suggest that the work time reduction alone is not sufficient to exert positive metabolic effects, but it should be associated with other healthy habits in the extra free time outside of work, like physical activity. that. On the other hand, in this study the increase of total cholesterol in the exercise group, without any significant reduction in LDL and waist-to-hip ratio, is unexpected and it could be related to other factors, such as diet, which this study did not analyze. Hence, it is impossible to state that a reduction in work hours has a significant and positive effect on biomarkers and metabolic outcomes, and other studies are therefore necessary to clarify these discrepancies.

Strengths and limitations

To date, this is the first literature review carried out in English to establish the relationship between reduced work hours and health effects. Furthermore, our review evaluates the effect of reduced working hours on both self-reported and measured health outcomes. Nevertheless, it has some limitations that must be acknowledged. First of all, the studies we included in our analysis were published in Scandinavian countries, traditionally known for placing a high value on work-life balance. Hence, the results of this review are not easily generalizable in other contexts, which could be different from a social, cultural and economic point of view. Furthermore, even taking into account excluded records, few studies addressed the issue of work time reduction, suggesting that, despite emerging as a relevant topic in public debate over the last few years, the issue of worktime reduction has not been studied enough so far. However, we could have missed some relevant studies, due to language limitations. In addition, three out of seven studies were evaluated as of weak quality by the authors. The main reason for this was the impossibility to ensure blinding of both participants and outcome assessors in this kind of studies. Nonetheless all of them had a longitudinal design, over a period of time ranging from 12 up to 36 months. Furthermore, in all studies except two, employment of extra-personnel allowed to prevent a compensatory increase in workload, which could have significantly undermined the effectiveness of worktime reduction.

CONCLUSIONS

Our review shows that the reduction of work hours is associated with an improvement of sleep habits, lower levels of stress and better working life quality. Despite a positive effect on certain general symptoms, such as cardiovascular and musculoskeletal ones, it is unclear whether work time reduction really determines an improvement in general health outcomes, such as self-perceived health and well-being. Furthermore, only one study evaluated biological markers as a quantitative outcome, with contrasting results. In addition, from the studies included in this review did not emerge a positive influence of work time reduction neither on quality of life outside of work, nor on physical activity. Hence, we can conclude that a reduction of work-hours, with preserved salary and without an increase in total workload, can exert a positive effect on specific health outcomes, especially stress and sleep, but it is also essential to understand how the extra free time is spent. So, further studies are needed to investigate whether providing prescriptions on how to spend extra free time healthily can improve workers' health. The conflicting results of this review suggest that work time reduction can be truly effective only if it determines a parallel improvement in healthy habits, which can then be main responsible for a real increase of overall health and quality of life.

Contributors

MRG and GV contributed to conceptualize and develop the study design. EB and AS built the search string and GV, DC, AS and EB contributed to articles screening, data extraction and data synthesis. AS and SR assessed the quality of the included articles and all authors contributed to drafting and revising the manuscript.

Competing interests

The authors declare that they have no conflict of interest

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Data availability statement

Extra data, such as search strings, is available by emailing armando.savatteri@unito.it

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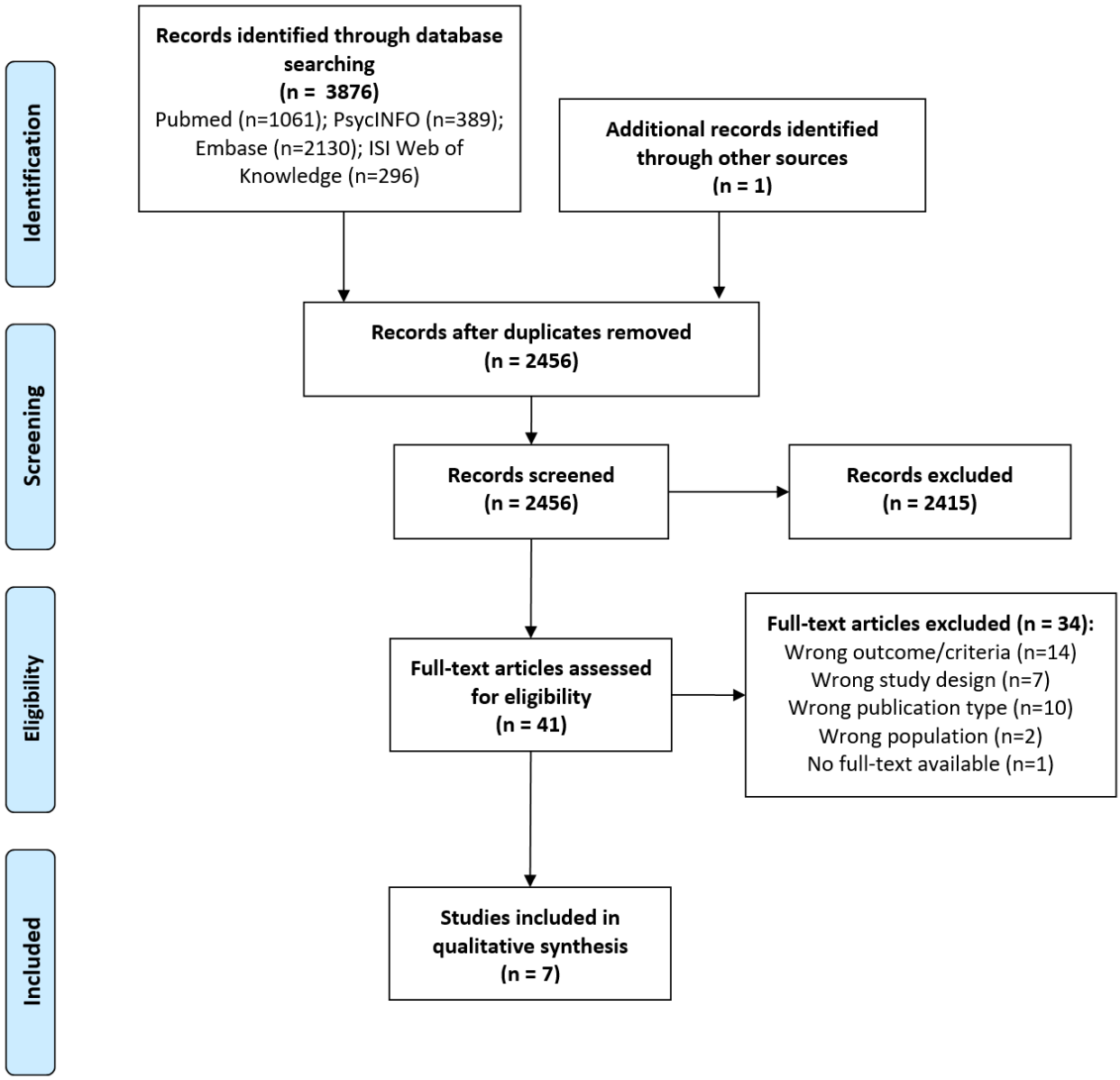

Figure 1 Systematic review: selection process. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta- Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

Supplemental File 1: search strategies

MEDLINE

("work"[Mesh] OR “Employment”[Mesh] OR work* [Tiab] OR “Employment”[Tiab])

AND

("Mental Health"[Mesh] OR "Occupational Health"[Mesh] OR "Quality of Life/psychology"[Mesh] OR "Occupational Diseases"[Mesh] OR “quality of life”[Tiab] OR "stress" [Tiab] OR "Mental Health" [Tiab] OR "Occupational Health" [Tiab] OR “sleep” [Tiab] OR “health” [Tiab] OR “mental disorders” [Tiab] OR “psychological disorders” [Tiab] OR “insomnia” [Tiab] OR “well-being” [Tiab] OR “anxiety” [Tiab] OR “depression” [Tiab] or “depressive disorder” [Tiab])

AND

(“worktime reduction” [Tiab] OR “reduced workhours” [Tiab] OR “reduced working hours” [Tiab] OR “weekly work hours” [Tiab] OR “weekly working hours” [Tiab] OR “shorter workday”[Tiab] OR “6-hour working day” [Tiab] OR “reduced work hours”[Tiab] OR “reduced worktime”[tiab] OR “work week” [Tiab] OR “workday” [Tiab])

PsycINFO

(DE "Work Load" OR DE "Work Scheduling" OR DE “Workplace intervention” OR TI “work” OR AB “work”)

AND

(DE “Mental Health” OR DE “Occupational Health” OR DE “Mental Disorders” OR DE “Occupational Stress” OR DE “Quality of life” OR TI “Stress” OR AB “Stress” OR TI “Mental Health” OR AB “Mental Health” OR TI “Occupational Health” OR AB “Occupational Health” OR TI “sleep” OR AB “sleep” OR TI “health” OR AB “health” OR TI “mental disorder*” OR AB “mental disorders” OR TI “psychological disorders” OR AB “psychological disorders” OR TI “insomnia” OR AB “insomnia” OR TI “well-being” OR AB “well-being” OR TI “anxiety” OR AB “anxiety” OR TI “depression” OR AB “depression” OR TI “depressive disorder” OR AB “depressive disorder”)

AND

(TI “worktime reduction” OR AB “worktime reduction” OR TI “reduced workhours” OR AB “reduced workhours” OR TI “reduced working hours” OR AB “reduced working hours” OR TI “weekly work hours” OR AB “weekly work hours” OR TI “weekly working hours” OR AB “weekly working hours” OR TI “shorter workday” OR AB “shorter workday” OR TI “6-hour working day” OR AB “6-hour working day” OR TI “reduced work hours” OR AB “reduced work hours” OR TI “reduced worktime” OR AB “reduced worktime” OR TI “work week” OR AB “work week” OR TI “workday” OR AB “workday”)

EMBASE

('work'/exp OR work*:ti,ab,kw OR ‘employment’/exp OR ‘employment’:ti,ab,kw)

AND

('mental health'/exp OR 'occupational health'/exp OR ‘quality of life’/exp OR ‘occupational disease’/exp OR ‘quality of life’:ti,ab,kw OR ‘stress’:ti,ab,kw OR ‘Mental Health’:ti,ab,kw OR ‘Occupational Health’:ti,ab,kw OR ‘sleep’:ti,ab,kw OR ‘health’:ti,ab,kw OR ‘mental disorders’:ti,ab,kw OR ‘psychological disorders’:ti,ab,kw OR ‘insomnia’:ti,ab,kw OR ‘well-being’:ti,ab,kw OR ‘anxiety’:ti,ab,kw OR ‘depression’:ti,ab,kw OR ‘depressive disorder’:ti,ab,kw)

AND

(‘worktime reduction’:ti,ab,kw OR ‘reduced workhours’:ti,ab,kw OR ‘reduced working hours’:ti,ab,kw OR ‘weekly work hours’:ti,ab,kw OR ‘weekly working hours’:ti,ab,kw OR ‘shorter workday’:ti,ab,kw OR ‘6-hour working

day':ti,ab,kw OR 'reduced work hours':ti,ab,kw OR 'reduced worktime':ti,ab,kw OR 'work week':ti,ab,kw OR 'workday':ti,ab,kw)

WEB OF SCIENCE

(job OR work*OR Employment)

AND

("quality of life" OR "stress" OR "Mental Health" OR "Occupational Health" OR "sleep" OR "health" OR "mental disorders" OR "psychological disorders" OR "insomnia" OR "well-being" OR "anxiety" OR "depression" OR "depressive disorder")

AND

("worktime reduction" OR "reduced workhours" OR "reduced working hours" OR "weekly work hours" OR "weekly working hours" OR "shorter workday" OR "6-hour working day" OR "reduced work hours" OR "reduced worktime" OR "work week" OR "workday")

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How the reduction of working hours could influence health outcomes: a systematic review of published studies

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Title page

Title:

How the reduction of working hours could influence health outcomes: a systematic review of published studies

Authors:

Gianluca Voglino[1], Armando Savatteri[1], Maria Rosaria Gualano[1], Dario Catozzi[1], Stefano Rousset[1], Edoardo Boietti[1], Fabrizio Bert[1], Roberta Siliquini[1,2]

[1]Department of Public Health and Paediatric Sciences, University of Turin, Torino, Italy.

[2]A.O.U. City of Health and Science of Turin, Turin, Italy.

Corresponding author:

Maria Rosaria Gualano, Via Santena 5 bis, 10126, Turin, Italy

Email: mariarosaria.gualano@unito.it

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ABSTRACT

Objectives

The health effects of worktime arrangements have been largely studied for long working hours, whereas a lack of knowledge remains regarding the potential health impact of reduced worktime interventions. Therefore, we conducted this review in order to assess the relationships between worktime reduction and health outcomes.

Design

Systematic review of published studies. Medline, PsycInfo, Embase and Web of Science databases were searched from January 2000 up to November 2019.

Outcomes

The primary outcome was the impact of reduced working time with retained salary on health effects, Interventional and observational studies providing a quantitative analysis of any health-related outcome were included. Studies with qualitative research methods were excluded,

Results

A total of 3876 published articles were identified and 7 studies were selected for the final analysis, all with a longitudinal interventional design. The sample size ranged from 63 participants to 580 workers, mostly from healthcare settings. Two studies assessed a work-time reduction to 6 hours per day; two studies evaluated a weekly work-time reduction of 25%; two studies evaluated simultaneously a reduced weekly work-time reduction proportionally to the amount of time worked and a 2.5 hours of physical activity program per week instead of work time; one study assessed a reduced weekly work-time reduction from 39 to 30 hours per week. A positive relationship between reduced working hours and working life quality, sleep and stress was observed. It is unclear whether work time reduction determined an improvement in general health outcomes, such as self-perceived health and well-being.

Conclusions

These findings suggest that the reduction of working hours whit retained salary could be an effective workplace intervention for the improvement of employees' well-being, especially regarding stress and sleep. Further studies in different contexts are needed to better evaluate the impact of worktime reduction on other health outcomes

Keywords: working hours; well-being; reducing worktime; working life quality

Strengths and limitations

- This is the first systematic review carried out in English to evaluate the impact of reduced working hours on both self-reported and measured health outcomes.
- All of the included studies had a longitudinal design, and in all studies except two the employment of extra-personnel allowed to prevent a compensatory increase in workload, which may have limited the effectiveness of worktime reduction.
- The included studies were carried out in the Scandinavian setting, thus limiting the generalizability of the results in other contexts, different from a social, cultural and economic point of view.

- Three out of seven studies had a weak quality according to the authors, and most of the studies were carried out in the healthcare setting.

INTRODUCTION

In Organization for Economic Cooperation and Development (OECD) countries the average working week consists of 37 hours[1]. OECD Data on annual average working hours show that, despite a declining trend in the amount of worked hours, many Countries still exceed the standard[2]. Working long hours is widely recognized as detrimental for employees' health. Indeed, several studies investigating the health effects of working overtime reported concerning findings, including increased risk of stroke, coronary heart disease, anxiety, depression, sleep disorders and adverse pregnancy outcomes in women [3–5]. Furthermore, a systematic assessment of evidence in literature with meta-analyses conducted by Rivera et al. found moderate-grade evidence linking long work-hours with stroke and low-grade evidence on the association between long work-hours with coronary disease, depression and pregnancy complications, including low birth weight babies and preterm delivery[6]. Long working hours have also been associated with reduced levels of work-life balance and increased work-family conflict[7].

Conversely, the effects of reduced work-hours have not been extensively examined as for long work-hours so far. Indeed, several experiments of reducing working time have been conducted throughout the years, both in the public and private sector. One of the most notable examples was the adoption of the "35-hour Workweek" between 1998 and 2000 by the French Government, which allowed the reduction of weekly working hours from 39 to 35, with the aim of fighting the high unemployment rates. However, aside from two surveys examining employees' satisfaction with modified work-hours and their work-family conflict, no other impacts on health and well-being have been evaluated [8,9]. The authors argue that the French 35-hours law increased overall dissatisfaction with modified work hours among employees, mainly because it did not take into account the heterogeneity of work organization. It appears that employees increased workload to maintain high productivity. Indeed, reducing working time without employing extra-personnel may compromise the fine balance between job demand and resources, which in turn would undermine employees' wellbeing[10]. Further interventions have been carried out on a company level. In Germany, Volkswagen reduced the working week from 36 to 28.8 hours[11] and more recently, Microsoft Japan tested a four-days work week[12]. Similarly, Perpetual Guardian, a New Zealand firm operating in the management of trusts, wills and estates, ran a four-day work week trial for all its 240 employees[13]. Although companies reported successful results, they did not take into consideration the potential health impact of these experiences.

Besides, there are few studies even in scientific literature that investigate the role of reduced work hours on workers' health. To our knowledge, only one literature review was conducted in 2005 and authors concluded that no relevant effects on health were observed[14]. However, the review was published in Swedish, hence it may represent an issue due to language barriers. Furthermore, the studies included in their work were mostly reports from Swedish ministerial committees and critical reviews on work time arrangements. Indeed, in the studies published before 2000 authors were primarily interested in the economic consequences of reducing work-hours, exploring the feasibility of the project, and little attention was paid to the effects of worktime reduction on the health of employees. Since 2000, several interventional studies have been published. Therefore, we decided to conduct a review of the literature examining studies focusing on the relationship between reduced working hours and health effects, published since 2000, in which employees retained their salary and proportionally decreased their work time and workload.

METHODS

Search strategy

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist we carried out a literature search for articles published in Medline, PsycInfo, Embase and Web of Science databases from January 2000 up to November 2019. Search terms included terms like “work”, “health”, “well-being”, “mental-health”, “worktime reduction”, “reduced work hours”. Full search strings for each database are provided in supplemental file 1. First, duplicates were excluded. Next, AS, DC, EB and GV independently screened retrieved sources by title and abstract following inclusion criteria. The same authors, always in an independent fashion, performed a full text review. Finally, consensus was reached through discussion about uncertain cases between all reviewers. Authors chose Rayyan QCRI as a tool for selecting and extracting relevant records[15].

Inclusion and exclusion criteria

We decided to include primary sources in any form, both interventional and observational studies, provided that quantitative analysis of any health-related outcome were performed. Hence, studies with qualitative research methods were excluded because we were interested on the effects of the interventions in terms of quantitatively measured outcomes. Articles had to investigate the association between reduced working time with retained salary and health effects, without excluding beforehand any category of workers. No salary reduction was considered crucial in order to avoid a selection bias possibly leading to exclude low-income workers. Another inclusion criterion was the replacement of working activity with any workplace-based intervention, provided that the amount of work hours was effectively reduced. Conversely, studies specifically focused on worktime reduction policies regarding activities with excessively long working hours, such as medical residency, were not consistent with the concept of reduced working hours and retained salary and were therefore excluded from our work. No language restriction was set. Due to the heterogeneity in the outcomes evaluated by the studies selected, a meta-analysis of data could not be conducted. Data and information regarding study design, Country, participant characteristics, observation period, intervention description, outcomes measured and results were extracted and synthesized in a systematic literature review.

Quality assessment

The quality of the included studies was assessed using the “Quality Assessment Tool for Quantitative Studies" developed by the Effective Public Health Practice Project (EPHPP)[16]. This quality appraisal tool provides a standardized means to assess study quality and develop recommendations for study findings considering eight components of study methodology: selection bias, study design, presence of confounders, blinding of participants and outcome assessors, validity and reliability of data collection methods and study dropouts and withdrawals. The overall quality of each study is then expressed as weak, moderate or strong. Previous evaluation of the tool has shown it to be valid and reliable[17]. Two reviewers, namely AS and SR, independently performed quality assessment. Discrepancies between the reviewers, such as differences in interpretation of criteria and studies, were resolved by discussion in order to reach consensus. The overall quality was found to be strong for three studies, moderate for one study and weak for three studies.

Patient and Public Involvement

No patient involved. Results will be disseminated throughout conferences and social media in order to enrich public debate on health outcomes of working hours rearrangements.

RESULTS

As results of the bibliographic search, a total of 3876 published articles were identified (**Figure 1**).

[Figure 1].

Duplicates were excluded and remaining 2456 records were reviewed. A full-text review was conducted on 40 articles. Finally, after evaluating the inclusion criteria, 7 articles were selected (1 article was originally added by citation chasing). In Total 7 articles, with a longitudinal interventional design, were included in the final analysis[18–24]. A brief summary of included articles is provided in **Table 1.**

The included studies were published between 2001[24]and 2017[18,19,23] and they were performed in northern Europe[18–24]. The sample size ranged from 63 participants[24] to 580 workers[19], mostly from healthcare settings[20–24]. Only one of the included studies enrolled workers from different workplaces in the public sector (Schiller et al. 2017). All the studies included had a longitudinal design and the observation period was between 12 months[20–22] and 23 months [23]. Although all the studies compared the intervention group to a control group with no work-time modifications, the intervention exanimated were different. In particular, two studies assessed a work-time reduction to 6 hours per day[22,23], two studies evaluated a weekly work-time reduction of 25%[18,19], two studies evaluated simultaneously a reduced weekly work-time reduction proportionally to the amount of time worked (reduced work hours group) and a 2.5 hours per week physical activity instead of work time program (physical exercise group)[20,21] and one study assessed a reduced weekly work-time reduction from 39 to 30 hours per week[24]. The included studies assessed a variety of different outcomes. In particular general symptoms[20,23,24], neuro-psychological symptoms[18,23,24], working life quality[18,20–24], quality of life[18,23,24], physical activity [20,23,24], sleep [18,19,23,24], musculoskeletal disorders[20,22,23] and biological markers[20] were assessed.

In particular, Åkerstedt and colleagues performed a longitudinal cohort study in 5 different healthcare settings, in order to compare the effects of work-hours reduction among health care and day care nursery personnel. The study involved a total of 63 nurses, 41 in the experimental group, a 9 hours reduction of the working week from 39 hours per week to 30 hours, retaining full pay, and 22 in the control group. The experimental group showed a significant improvement for heart/respiratory symptoms, mental fatigue, sleep quality, time for social, time for family/friends, influence on work-hours and satisfaction with work-hours, Additionally, most of these variables also showed a significant change over time. Furthermore, there was a positive change over time for pain/ache complaints, nervous symptoms, gastrointestinal complaints, insomnia complaints, refreshed at awakening, sleepiness at work/leisure time, involuntary sleep at work and leisure time and satisfaction with the work situation. On the contrary, no significant interaction was found between reduced work hours and exercise, weight and BMI[24].

Similar results were published by Barck-Holst and colleagues. They performed a longitudinal quasi experimental study involving seven public social service agencies. Employees in the intervention group reduced their work hours by 25% but retained their previous salary and their organizations were fully reimbursed and staff to compensate the loss of work hours was hired. After controlling for baseline values, gender and age, there was a significant difference in change over time between intervention and control group during workdays on the restorative sleep index, average stress level, the stress index, the memory difficulties index, the negative emotion index, average sleepiness and the fatigue and exhaustion index[18].

Table 1. Characteristics of the studies included in systematic review.

Author	Study Design	Country & Participants	Observation period	Intervention description	Outcome (measures)	Results	Quality assessment rating
Akersredt et al, 2001	Longitudinal intervention study	Sweden, N = 63, full-time workers in health care service.	36 Months	Intervention group (N=41): reduced WWH from 39 hrs/week to 30 hrs/week. Control group (N=22): unchanged working time.	– **General symptoms**, – **neuro-psychological symptoms**, – **working life quality**, – **quality of life**, – **physical activity**, – **sleep**	Subjective sleep quality (SSQ), mental fatigue and heart/respiratory symptoms, time for social activity, time for family and friends improved significantly more in the experimental group than in the control group. No significant effects for sickness absence or self-rated health.	Weak
Wergeland et al, 2003	Longitudinal intervention study	Norway and Sweden, N = 403. Workers in nursing homes, home care services and kindergartens	12-22 Months	Intervention group: reduced DWH to 6 hrs/day. Reference group: unchanged working time.	– **Musculoskeletal disorders**, (shoulder-neck and back pain frequency and work-related physical exhaustion) – **working life quality**	A significant interaction was found for neck-shoulder pain and for exhaustion after work in the intervention group. No significant effects were observed in the reference group.	Weak
von Thiele et al, 2008	Longitudinal intervention study	Sweden, N = 177 employees from 6 workplaces at public dental health care organization	12 Months	PE group: 2.5 hrs/week of physical activity instead of work time. Reduced work hours group: reduced WWH proportionally to the amount of time worked. Reference group: unchanged working time.	– **General symptoms**, – **musculoskeletal disorders**, – **working life quality** (work-home interference, recovery from work and work ability), – **physical activity** – **biological markers** (blood lipids, neuroendocrine markers, cardiovascular measures)	Physical activity increased in all three groups. Decreased glucose and upper-extremity disorders were found in the exercise group, while increased HDL and waist-to-hip ratio was found among those working reduced hours. Participants working reduced hours also had increased total cholesterol and no changes in LDL-to-HDL ratio.	Strong
von Thiele et al, 2011	Longitudinal intervention study	Sweden, N = 177 employees from 6 workplaces at a public dental health care organization	12 Months	PE group: 2.5 hrs/week of physical activity instead of work time. Reduced work hours group: reduced WWH proportionally to the amount of time worked.	– **On-the-job productivity**, – **working life quality** (sickness presenteeism and sickness absenteeism) – **Objective production levels** (administrative records)	Physical activity was associated with an increase in self-rated productivity in terms of increased quantity of work and work-ability and decreased frequency and number of days of sickness absence. No effect was found in the work hours reduction group. In all three groups there was an increase in	Strong

				Reference group: unchanged working time.		the number of treated patients per therapist, significantly greater in the reduced work hours group.	
Barck-Holst et al, 2017	Longitudinal quasi-experimental trial	Sweden, N= 204 A total of 125 participants were deemed as per protocol	18 Months	Intervention group: reduced work hours by 25%. Reference group: unchanged working time.	– **Neuro-psychological symptoms** – **working life quality** (demands, control, social support, instrumental manager support, instrumental coworker support, work intrusion on private life) – **sleep**	The intervention group significantly improved restorative sleep, stress, memory difficulties, negative emotion, sleepiness, fatigue and exhaustion on both work days and weekends. Improved demands, instrumental manager support and work intrusion on private life were observed in the intervention group. Sleep quality was improved on weekends.	Moderate
Lorentzon 2017	Longitudinal intervention study	Sweden, N = 124, nurses working in a centre for the elderly	23 Months	Intervention group: work-time reduction to 6 hrs/day. Reference group: unchanged working time.	– **General symptoms**, – **musculoskeletal disorders**, – **neuro-psychological symptoms** (alertness level, perceived fatigue, energy left at home, feeling calm, perceived stress), – **working life quality** (collaboration and personal develoment, sick leaves), – **physical activity** – **sleep**	Good perceived health and alertness level, satisfactory level of perceived fatigue. Having energy left at home, feeling calm, satisfactory levels of stress, average sleep time increased in intervention group. General symptoms, sleep and musculoskeletal symptoms improved in the intervention group, and dropped in the control group. Collaboration and personal development improved; improved sense of collaboration between nurses. Sick leave increased in the intervention group.	Weak
Schiller et al, 2017	Longitudinal controlled intervention study	Sweden, N=580, workers from 33 workplaces in the public sector	18 Months	Intervention group: reduced WWH by 25%. Reference group: unchanged working time.	– **Sleep** – **perceived stress**, feeling of worries	On workdays, the intervention group displayed improved SSQ, 23 minutes extended sleep duration, decreased sleepiness and perceived stress and less feelings of worries and stress at bedtime when work hours were reduced. The intervention showed positive effects on days off, except for sleep duration.	Strong

In addition, a longitudinal controlled intervention study evaluating a 25% reduction of weekly work hours was published in 2017 by Schiller and colleagues. In this paper, participants worked at 33 different workplaces, in four sectors: social services (n=170); technical services (n=236); care and welfare (n=159); call-centre (n=71). The intervention group (n=370) reduced work-time to 75% with preserved salary during 18 months. Data were collected at baseline (1–2 months before the intervention) and approximately 9 months and 18 months after the introduction of reduced work hours. On workdays, the intervention group (N=354) displayed improved subjective sleep quality, 23 minutes extended sleep duration (over the whole period of 18 months), decreased sleepiness and perceived stress and less feelings of worries and stress at bedtime when work hours were reduced (P<0.002). Gender, age, having children living at home, and baseline values of sleep quality and worries and stress at bedtime, considered as additional between-group factors, did not influence the results significantly[19].

Similar outcomes were assessed in a cohort study, performed between February 2015 and December 2016. In this paper, 68 nurses from the intervention group had their working time reduced to 6 hours per day with retaining their full-time pay. On the contrary, nurses in the control group (N=56) had no working hours reduction. Outcomes were assessed using several questionnaires before, during and after the experimentation. In particular, the sick leave was 6.1% in the intervention group and 12.3% in the control group. Furthermore, health perceived as good (72% vs 60%), alertness level perceived as good (65% vs 50%), satisfactory level of perceived fatigue (+20% vs -22%), feeling having a lot of energy left when arriving at home (51% vs 7%, both starting from 20%), feeling calm (64% vs 45%), satisfactory levels of stress (+20%, -5%), average sleep time (7 hours vs 5.8 hours) had better values in the intervention group compared to the control group. Additionally, in the intervention group, satisfaction regarding physical activity increased (+ 7% vs -15%). Finally, general symptoms, sleep and symptoms affecting the musculoskeletal system improved in the intervention group, and dropped for the control group[23].

Similarly, a previous paper assessing the occurrence of musculoskeletal disorders in the experimental and control groups was published by Wegerland and colleagues. In their longitudinal intervention study, involving subjects enrolled from different institutions, workers in the experimental group had their daily work-hours reduced to 6 hours, with retained salary and extra personnel employed to compensate for the reduction in work-hours. Participants were involved through a self-administered questionnaire about pain in the neck-shoulder and back regions prior to and during the work-time reduction. By using a multivariable analysis on data from all the institutions, authors found a significant interaction for neck-shoulder pain (p=0.034) and exhaustion after work (P=0.009). No significant interaction was found for back pain. Additionally, the intervention group showed increased job satisfaction after the reduction in work-hours[22].

Finally, von Thiele and colleagues performed two longitudinal studies in Stockholm, Sweden, involving employees from six workplaces in a large public dental health care organization, randomly allocated to one of three groups: physical-exercise group (PE), reduced work-hours group (RWH), and reference group (R). At the two workplaces acting as reference, no intervention was carried out; at the two workplaces in the PE group, 2.5 hours of weekly work hours were allocated to mandatory physical exercise on two different days; at the two workplaces in the RWH group, full-time weekly hours were reduced from 40 hours/week to 37.5 hours/week. All employees in the intervention groups retained their salaries, and no additional personnel were employed. The final sample consisted of 177 employees, mainly women. Participants were instructed to complete self-ratings at baseline, after 6 months and after 12 months[20,21].

In the paper published in 2008[20] blood samples were and questionnaire were used to explore the areas of physical activity, recovery from work stress, work-home interference, self-related health, work ability, general and musculoskeletal symptoms. The results showed a significant increase in physical exercise in all three groups over time, with post-hoc tests showed that the increase in the PE group was significantly greater than in the other two groups. Additionally, the analysis

showed increasing levels of all of the blood lipids in the reference group (p<0.001, for total cholesterol; p=0.016, for triglycerides; p=0.003, for HDL; p<0.001, for LDL). In the RWH group, total cholesterol and HDL had increased significantly (p=0.019, for total cholesterol; p=0.016, for HDL), while only total cholesterol had increased significantly in the physical-exercise group (p=0.018). Glucose showed a significant time × group effect (p=0.04), and a significant decrease in the PE group (p=0.036). Work ability decreased in the reference group (p=0.005); similar results were found for general symptoms[20].

In the paper published in 2011[21], three outcomes were measured: on-the-job productivity, measured with a single item asking the respondents to rate their current work ability as compared with their individual best work ability on a ten-point scale; sickness presenteeism and sickness absenteeism, assessed with three questions; objective production levels, in terms of the number of treated patients and the number of therapists per month for each participating worksite as well as for all worksites combined. The results showed a significant increase in self-rated quantity of work (p = 0.029) and work ability (p = 0.046) in the PE group. Work ability decreased significantly in the reference group (p = 0.004). In the PE group, frequency of sickness absence (p = 0.037) and sickness duration (p = 0.029) decreased significantly. In the reference group changes in sickness absence duration (p = 0.041) and sickness presenteeism (p=0.028) were each significant[21].

DISCUSSION

The purpose of this review was to analyze the results of studies conducted in order to explore the consequences of work time reduction on health outcomes, which is an emerging and debated issue especially in western countries with a developed welfare system, as the ones in Northern Europe. Unfortunately, there is no standard health outcome in the literature that can be used as a comparison in all studies to investigate the effects of reducing working hours on workers' health such as self-perceived health and well-being. Then, we analysed 7 published articles exploring several different health outcomes, and all of them were investigated and discussed.

General and physical symptoms

Four longitudinal studies analysed the relationship between work-time reduction and a broad spectrum of general and physical symptoms. Åkerstedt et al.[24] found a significant improvement of hearth/respiratory symptoms in the experimental group compared to the control group. However, when self-rated health was explored as an outcome, they did not find any statistically significant differences before and after the intervention, neither between the experimental and the control group, nor over time among the same group. Similar results were obtained by von Thiele et al., which did not find any significant differences between the intervention and the reference group regarding neither general symptoms nor self-rated health [20]. As the Authors suggest, the lack of significant results could be explained by the fact that the study was carried out on healthy subjects, consequently reducing the effect size, especially for self-ratings. On the other hand, Lorentzon et al. found an improvement in perceived health in the intervention group compared to the control group[23]. Wergeland et al., in their three-project study, found a significant reduction of neck/shoulder and back pain prevalence in the intervention group[22], in agreement with Lorentzon et al.[23], possibly due to a reduction of time spent in the sitting position during work-time.

Data are still contradictory and it is possible to hypothesize that the real impact of workload reduction on general and physical symptoms, despite having a possible effect on specific physical symptoms, remains to be determined through further larger studies.

Neuro-psychological symptoms

Four studies evaluated the relationship between work-time reduction and neuro-psychological symptoms [18,19,23,24]. General stress was the most frequently explored outcome. Barck-Holst et al. found an average stress level and a stress index

significantly decreased in the intervention group, but this difference was higher on workdays compared to weekends [18]. This is consistent with the results of Schiller et al., who found a significant reduction of stress both during the day and at bedtime in the intervention group[19]. Lorentzon et al. found that workers with reduced work-time reported satisfactory levels of stress and perceived fatigue more often in comparison with workers in the control group[23]. Åkerstedt et al. found a significant reduction of mental fatigue in the experimental group. In addition, they found a reduction of nervous symptoms and pain/ache complaints over time, but this difference was not significant between the experimental and the control group. As the authors suggest, the project in itself may have increased the awareness of work organization and health, with positive effects on both groups[24].

Globally, these results suggest that the reduction of work-time is associated with a significant improvement of stress and other neuro-psychological symptoms, probably due to the decrease of workload and the consequent increase of free time for leisure activities.

Sleep

Sleep condition was evaluated in five studies[18–20,23,24]. Åkerstedt et al. and Schiller et al. measured subjective sleep quality (SSQ) using the same items and improvements were observed significantly more in the intervention group than in the reference group[19,24]. Similar results were reported by Barck-Holst et al.[18]. In their study on nurses, Lorentzon et al. found that those nurses working less hours as a part of the experiment averagely slept more than nurses who kept working with regular hours[23]. von Tiele et al. evaluated the presence of sleep disturbances as part of a more comprehensive questionnaire - a modified version of QPSNordic - investigating general symptoms[20,25]. Although they found no improvements in the experimental group regarding general symptoms, we cannot tell whether the occurrence of sleep disturbances taken alone differed among their participants. Despite different measurements being adopted, almost all studies found a significant improvement in sleep among intervention groups compared to control groups. As already reported by previous research, long working hours have shown to negatively influence sleep in many ways[26,27] and this effect may be explained by higher work demands and work-related stress[28]. Thus, we hypothesize that the positive effects of reduced work-time on stress and workload may explain the positive effects on sleep.

Quality of working life

All studies except one investigated whether reduced work hours had measurable effects on working life quality[18–20,22–24]. Åkerstedt et al. found no effects on work demands, but workload had decreased for both intervention and control group. As hypothesized by the authors, it is possible that an increased awareness of work organization following the experiment may be the cause of such findings[24]. No effects on sickness absence were found, as opposed to von Tiele et al., where employees in the intervention group decreased frequency and number of days of sickness absence, as well as perceiving improved self-rated work ability[20]. Other work-related factors were reported as significantly improved after the experiment, including exhaustion after work, sense of collaboration between colleagues, demands, instrumental manager support and work intrusion on private life[18,22,23]. The last finding is in line with results from Anntila et al., in which shorter working hours were associated with positive work-family interaction[29]. Overall, reduced working hours seem to improve working-life quality.

Quality of life

Three studies evaluated the effect of work-time reduction on quality of life outside of work[20,23,24]. Åkerstedt et al. found a significant increase in time for family/friends and social activities in the experimental group, and this increase was significant also over time among the experimental group[24]. However, as mentioned above, they did not find any improvement in the self-rated health. It is possible that the extra free time, despite exerting a positive effect on general quality of life, does not necessarily determine an improvement in self-perceived health. These results are consistent with

the results of von Thiele et al., who did not find any significant differences regarding work-time interaction, neither between the intervention groups and the reference group nor over time among the same groups [20]. In addition, Lorentzon et al. found that healthy behaviours, such as healthy eating, did not improve in the intervention group[23]. Overall, these results suggest that work time reduction per se is not necessarily associated with an improvement in the balance between work and private life. Hence, beside work-time reduction, it is also important to focus on how the extra free time is spent, in order to make the reduction in work-time and workload really effective in exerting positive effects on individual health.

Physical activity

Physical activity was evaluated by three studies[20,23,24]. While Åkerstedt et al. found no significant improvements regarding physical exercise[24], von Thiele et al and Lorentzon et al observed an increase in physical activity in participants experimenting reduced work hours[20,23]. However, the study design by von Thiele et al. consisted in three groups (physical activity group, reduced work hours group and reference group) and such increases were observed in all of them[20]. We do not know whether these changes were a consequence of an increased awareness towards physical exercise brought by the experiment. Moreover, the number of studies evaluating this specific outcome are too few. Although previous research has shown that there seems to be an inverse association between work hours and physical activity[30], for the reasons listed above it cannot be concluded that reduced work hours are associated with increased levels of physical activity. Indeed, we do not know whether employees working for reduced work time would engage their spare time into physical exercise. Hence, more experiments are needed to better determine this subject.

Biological markers

Only von Thiele et al. evaluated the effect of work-time reduction on several biological markers[20]. They found in the reference group increasing levels of all of the blood lipids. In the reduced work hours group, total cholesterol and HDL had increased significantly, while only total cholesterol had increased significantly in the physical-exercise group. Regarding metabolic measures, glucose showed a significant decrease in the physical-exercise group only, while the waist-to-hip ratio increased in the reduced work hours group. These last findings suggest that the work time reduction alone is not sufficient to exert positive metabolic effects, but it should be associated with other healthy habits in the extra free time outside of work, like physical activity. that. On the other hand, in this study the increase of total cholesterol in the exercise group, without any significant reduction in LDL and waist-to-hip ratio, is unexpected and it could be related to other factors, such as diet, which this study did not analyze. Hence, it is impossible to state that a reduction in work hours has a significant and positive effect on biomarkers and metabolic outcomes, and other studies are therefore necessary to clarify these discrepancies.

Strengths and limitations

To date, this is the first literature review carried out in English to establish the relationship between reduced work hours and health effects. Furthermore, our review evaluates the effect of reduced working hours on both self-reported and measured health outcomes. Nevertheless, it has some limitations that must be acknowledged. First of all, the studies we included in our analysis were published in Scandinavian countries, traditionally known for placing a high value on work-life balance. Hence, the results of this review are not easily generalizable in other contexts, which could be different from a social, cultural and economic point of view. Furthermore, even taking into account excluded records, few studies addressed the issue of work time reduction, suggesting that, despite emerging as a relevant topic in public debate over the last few years, the issue of worktime reduction has not been studied enough so far. However, we could have missed some relevant studies, due to language limitations. In addition, three out of seven studies were evaluated as of weak quality by the authors. The main reason for this was the impossibility to ensure blinding of both participants and outcome assessors in this kind of studies. Nonetheless all of them had a longitudinal design, over a period of time ranging from 12 up to 36

months. Furthermore, in all studies except two, employment of extra-personnel allowed to prevent a compensatory increase in workload, which could have significantly undermined the effectiveness of worktime reduction.

In the end, a great limitation of our review is the remarkable heterogeneity of workers in the seven different studies. Most of the studies focus on health service workers and this may limit the generalizability of the review to the context of health services that represent a particular work setting with high emotional stress.

CONCLUSIONS

Factors affecting health in the workplace are manifold and include organizational, cultural and social aspects. It is not clear whether changes in working hours alone is a robust enough factor that influences "stress" or other health variables in workers.

However, our review shows that the reduction of work hours is associated with an improvement of sleep habits, lower levels of stress and better working life quality. We did not find a positive influence of work time reduction neither on quality of life outside of work, nor on physical activity. Hence, we can conclude that a reduction of work-hours, with preserved salary and without an increase in total workload, may exert a positive effect on specific health outcomes, especially stress and sleep, but it is also essential to to investigate how other work variables such as load, type and organization of work affect the health of the worker. Another important factor that could affect health is how the extra free time is spent. Therefore, further studies are needed to investigate the correlation between different working variables, working time and extra free time with standardized health outcomes in order to evaluate the real impact of working time on workers' health. It is also important to study whether providing prescriptions on how to spend extra free time healthily can improve workers' health. The conflicting results of this review suggest that work time reduction may be truly effective only if it determines a parallel improvement in healthy habits, which can then be main responsible for a real increase of overall health and quality of life.

Data availability

All data relevant to the study are included in the article or uploaded as supplementary information.

Competing interests

The authors declare that they have no conflict of interest.

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Ethics Statement

For this type of study Ethics Commitee approval is not required.

Contributorship Statement

The review was conceived by GV, MRG and RS. Data extraction was carried out by GV, AS, DC, SR and EB with support from MRG, FB and RS. Reporting of findings was led by GV and MRG with support from FB and RS. All authors contributed to manuscript preparation and approved the final version.

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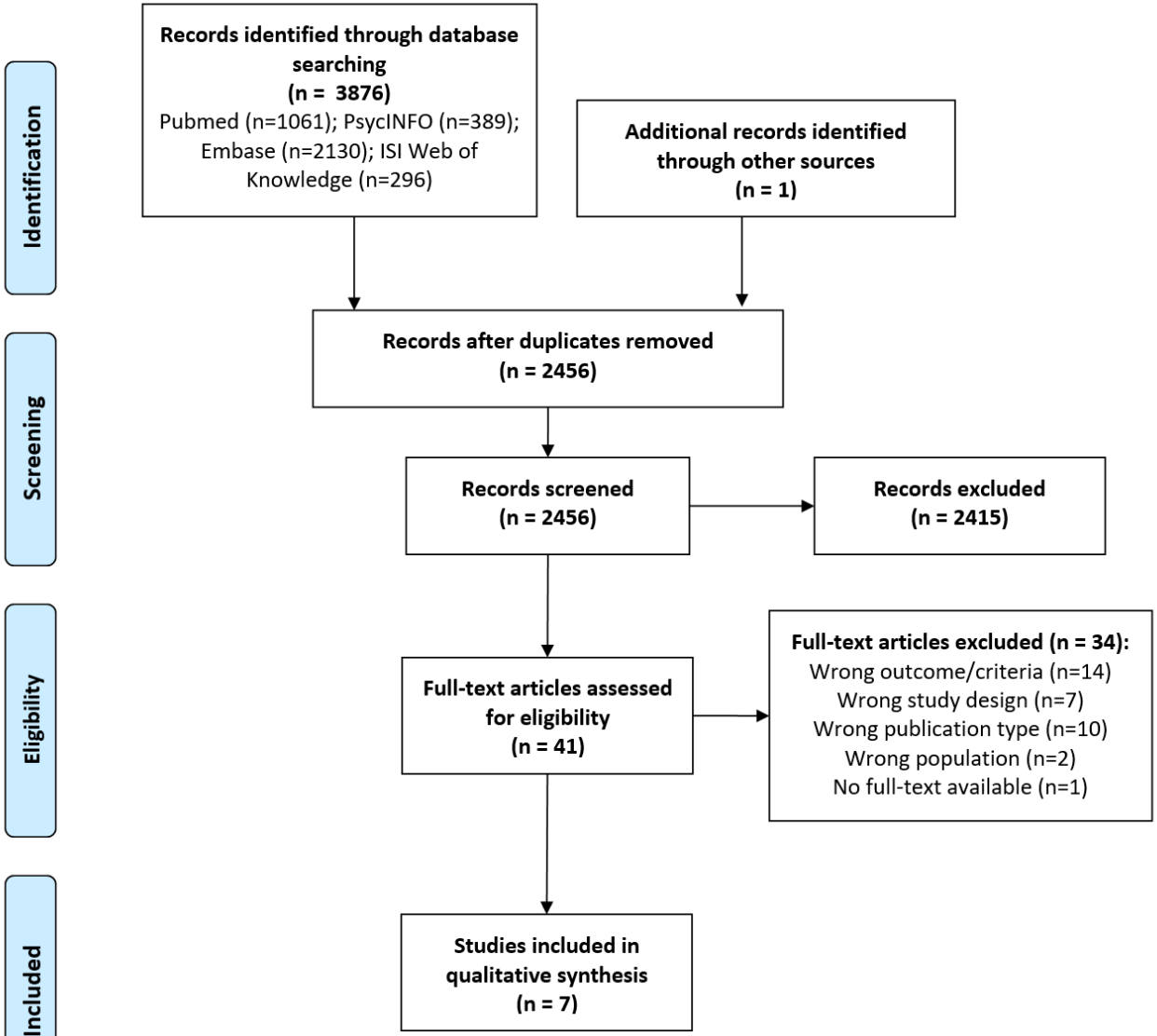
Figure Legends

Figure 1 Systematic review: selection process. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta- Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

Table 1 Characteristics of the studies included in systematic review.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 3876)
Pubmed (n=1061); PsycINFO (n=389); Embase (n=2130); ISI Web of Knowledge (n=296)
Additional records identified through other sources (n = 1)
Records after duplicates removed (n = 2456)
Records screened (n = 2456)
Records excluded (n = 2415)
Full-text articles assessed for eligibility (n = 41)
Full-text articles excluded (n = 34):
Wrong outcome/criteria (n=14)
Wrong study design (n=7)
Wrong publication type (n=10)
Wrong population (n=2)
No full-text available (n=1)
Studies included in qualitative synthesis (n = 7)

Supplemental File 1: search strategies

MEDLINE

("work"[Mesh] OR “Employment”[Mesh] OR work* [Tiab] OR “Employment”[Tiab])

AND

("Mental Health"[Mesh] OR "Occupational Health"[Mesh] OR "Quality of Life/psychology"[Mesh] OR "Occupational Diseases"[Mesh] OR “quality of life”[Tiab] OR "stress" [Tiab] OR "Mental Health" [Tiab] OR "Occupational Health" [Tiab] OR “sleep” [Tiab] OR “health” [Tiab] OR “mental disorders” [Tiab] OR “psychological disorders” [Tiab] OR “insomnia” [Tiab] OR “well-being” [Tiab] OR “anxiety” [Tiab] OR “depression” [Tiab] or “depressive disorder” [Tiab])

AND

(“worktime reduction” [Tiab] OR “reduced workhours” [Tiab] OR “reduced working hours” [Tiab] OR “weekly work hours” [Tiab] OR “weekly working hours” [Tiab] OR “shorter workday”[Tiab] OR “6-hour working day” [Tiab] OR “reduced work hours”[Tiab] OR “reduced worktime”[tiab] OR “work week” [Tiab] OR “workday” [Tiab])

PsycINFO

(DE "Work Load" OR DE "Work Scheduling" OR DE “Workplace intervention” OR TI “work” OR AB “work”)

AND

(DE “Mental Health” OR DE “Occupational Health” OR DE “Mental Disorders” OR DE “Occupational Stress” OR DE “Quality of life” OR TI “Stress” OR AB “Stress” OR TI “Mental Health” OR AB “Mental Health” OR TI “Occupational Health” OR AB “Occupational Health” OR TI “sleep” OR AB “sleep” OR TI “health” OR AB “health” OR TI “mental disorder*” OR AB “mental disorders” OR TI “psychological disorders” OR AB “psychological disorders” OR TI “insomnia” OR AB “insomnia” OR TI “well-being” OR AB “well-being” OR TI “anxiety” OR AB “anxiety” OR TI “depression” OR AB “depression” OR TI “depressive disorder” OR AB “depressive disorder”)

AND

(TI “worktime reduction” OR AB “worktime reduction” OR TI “reduced workhours” OR AB “reduced workhours” OR TI “reduced working hours” OR AB “reduced working hours” OR TI “weekly work hours” OR AB “weekly work hours” OR TI “weekly working hours” OR AB “weekly working hours” OR TI “shorter workday” OR AB “shorter workday” OR TI “6-hour working day” OR AB “6-hour working day” OR TI “reduced work hours” OR AB “reduced work hours” OR TI “reduced worktime” OR AB “reduced worktime” OR TI “work week” OR AB “work week” OR TI “workday” OR AB “workday”)

EMBASE

('work'/exp OR work*:ti,ab,kw OR ‘employment’/exp OR ‘employment’:ti,ab,kw)

AND

('mental health'/exp OR 'occupational health'/exp OR ‘quality of life’/exp OR ‘occupational disease’/exp OR ‘quality of life’:ti,ab,kw OR ‘stress’:ti,ab,kw OR ‘Mental Health’:ti,ab,kw OR ‘Occupational Health’:ti,ab,kw OR ‘sleep’:ti,ab,kw OR ‘health’:ti,ab,kw OR ‘mental disorders’:ti,ab,kw OR ‘psychological disorders’:ti,ab,kw OR ‘insomnia’:ti,ab,kw OR ‘well-being’:ti,ab,kw OR ‘anxiety’:ti,ab,kw OR ‘depression’:ti,ab,kw OR ‘depressive disorder’:ti,ab,kw)

AND

(‘worktime reduction’:ti,ab,kw OR ‘reduced workhours’:ti,ab,kw OR ‘reduced working hours’:ti,ab,kw OR ‘weekly work hours’:ti,ab,kw OR ‘weekly working hours’:ti,ab,kw OR ‘shorter workday’:ti,ab,kw OR ‘6-hour working

day':ti,ab,kw OR 'reduced work hours':ti,ab,kw OR 'reduced worktime':ti,ab,kw OR 'work week':ti,ab,kw OR 'workday':ti,ab,kw)

WEB OF SCIENCE

(job OR work*OR Employment)

AND

("quality of life" OR "stress" OR "Mental Health" OR "Occupational Health" OR "sleep" OR "health" OR "mental disorders" OR "psychological disorders" OR "insomnia" OR "well-being" OR "anxiety" OR "depression" OR "depressive disorder")

AND

("worktime reduction" OR "reduced workhours" OR "reduced working hours" OR "weekly work hours" OR "weekly working hours" OR "shorter workday" OR "6-hour working day" OR "reduced work hours" OR "reduced worktime" OR "work week" OR "workday")

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	p.1 line 4
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p. 3 lines 97-119
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p. 4 lines 119-121
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p. 4 lines 135-147
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p. 4 lines 126-128
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	p. 4 lines 128-133
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p. 4 lines 128-133
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p. 4 lines 145-147
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	p. 11 lines 171-173
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	pp. 10-11 lines 162-171
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	pp. 12-13 lines 247-255
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	pp. 4-12 lines 150-245
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	p. 4 lines 135-147
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	p. 5 lines 157-158

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p. 5 lines 157-158
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	p. 5 lines 155-157
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	/
Study characteristics	17	Cite each included study and present its characteristics.	pp. 11-12 lines 174-245
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	pp. 5-10 Table 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	pp. 5-10 Table 1
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	pp. 5-10 Table 1
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	pp. 13-15 lines 265-352
	23b	Discuss any limitations of the evidence included in the review.	p. 15 lines 356-369
	23c	Discuss any limitations of the review processes used.	p. 15 lines 361-362
	23d	Discuss implications of the results for practice, policy, and future research.	pp. 15-16

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
			lines 372-386
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	N/A
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	N/A
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p. 16 line 392
Competing interests	26	Declare any competing interests of review authors.	p. 16 line 389
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	p.4 line 129

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

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How the reduction of working hours could influence health outcomes: a systematic review of published studies

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Title page

Title:

How the reduction of working hours could influence health outcomes: a systematic review of published studies

Authors:

Gianluca Voglino[1], Armando Savatteri[1], Maria Rosaria Gualano[1], Dario Catozzi[1], Stefano Rousset[1], Edoardo Boietti[1], Fabrizio Bert[1], Roberta Siliquini[1,2]

[1]Department of Public Health and Paediatric Sciences, University of Turin, Torino, Italy.

[2]A.O.U. City of Health and Science of Turin, Turin, Italy.

Corresponding author:

Maria Rosaria Gualano, Via Santena 5 bis, 10126, Turin, Italy

Email: mariarosaria.gualano@unito.it

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ABSTRACT

Objectives

The health effects of worktime arrangements have been largely studied for long working hours, whereas a lack of knowledge remains regarding the potential health impact of reduced worktime interventions. Therefore, we conducted this review in order to assess the relationships between worktime reduction and health outcomes.

Design

Systematic review of published studies. Medline, PsycInfo, Embase and Web of Science databases were searched from January 2000 up to November 2019.

Outcomes

The primary outcome was the impact of reduced working time with retained salary on health effects, Interventional and observational studies providing a quantitative analysis of any health-related outcome were included. Studies with qualitative research methods were excluded,

Results

A total of 3876 published articles were identified and 7 studies were selected for the final analysis, all with a longitudinal interventional design. The sample size ranged from 63 participants to 580 workers, mostly from healthcare settings. Two studies assessed a work-time reduction to 6 hours per day; two studies evaluated a weekly work-time reduction of 25%; two studies evaluated simultaneously a reduced weekly work-time reduction proportionally to the amount of time worked and a 2.5 hours of physical activity program per week instead of work time; one study assessed a reduced weekly work-time reduction from 39 to 30 hours per week. A positive relationship between reduced working hours and working life quality, sleep and stress was observed. It is unclear whether work time reduction determined an improvement in general health outcomes, such as self-perceived health and well-being.

Conclusions

These findings suggest that the reduction of working hours with retained salary could be an effective workplace intervention for the improvement of employees' well-being, especially regarding stress and sleep. Further studies in different contexts are needed to better evaluate the impact of worktime reduction on other health outcomes

Keywords: working hours; well-being; reducing worktime; working life quality

Strengths and limitations

- This is the first systematic review carried out in English to evaluate the impact of reduced working hours on both self-reported and measured health outcomes.
- All of the included studies had a longitudinal design, and in all studies except two the employment of extra-personnel allowed to prevent a compensatory increase in workload, which may have limited the effectiveness of worktime reduction.
- The included studies were carried out in the Scandinavian setting, thus limiting the generalizability of the results in other contexts, different from a social, cultural and economic point of view.

- Three out of seven studies had a weak quality according to the authors, and most of the studies were carried out in the healthcare setting.

INTRODUCTION

In Organization for Economic Cooperation and Development (OECD) countries the average working week consists of 37 hours[1]. OECD Data on annual average working hours show that, despite a declining trend in the amount of worked hours, many Countries still exceed the standard[2]. Working long hours is widely recognized as detrimental for employees' health. Indeed, several studies investigating the health effects of working overtime reported concerning findings, including increased risk of stroke, coronary heart disease, anxiety, depression, sleep disorders and adverse pregnancy outcomes in women [3–5]. Furthermore, a systematic assessment of evidence in literature with meta-analyses conducted by Rivera et al. found moderate-grade evidence linking long work-hours with stroke and low-grade evidence on the association between long work-hours with coronary disease, depression and pregnancy complications, including low birth weight babies and preterm delivery[6]. Long working hours have also been associated with reduced levels of work-life balance and increased work-family conflict[7].

Conversely, the effects of reduced work-hours have not been extensively examined as for long work-hours so far. Indeed, several experiments of reducing working time have been conducted throughout the years, both in the public and private sector. One of the most notable examples was the adoption of the "35-hour Workweek" between 1998 and 2000 by the French Government, which allowed the reduction of weekly working hours from 39 to 35, with the aim of fighting the high unemployment rates. However, aside from two surveys examining employees' satisfaction with modified work-hours and their work-family conflict, no other impacts on health and well-being have been evaluated [8,9]. The authors argue that the French 35-hours law increased overall dissatisfaction with modified work hours among employees, mainly because it did not take into account the heterogeneity of work organization. It appears that employees increased workload to maintain high productivity. Indeed, reducing working time without employing extra-personnel may compromise the fine balance between job demand and resources, which in turn would undermine employees' wellbeing[10]. Further interventions have been carried out on a company level. In Germany, Volkswagen reduced the working week from 36 to 28.8 hours[11] and more recently, Microsoft Japan tested a four-days work week[12]. Similarly, Perpetual Guardian, a New Zealand firm operating in the management of trusts, wills and estates, ran a four-day work week trial for all its 240 employees[13]. Although companies reported successful results, they did not take into consideration the potential health impact of these experiences.

Besides, there are few studies even in scientific literature that investigate the role of reduced work hours on workers' health. To our knowledge, only one literature review was conducted in 2005 and authors concluded that no relevant effects on health were observed[14]. However, the review was published in Swedish, hence it may represent an issue due to language barriers. Furthermore, the studies included in their work were mostly reports from Swedish ministerial committees and critical reviews on work time arrangements. Indeed, in the studies published before 2000 authors were primarily interested in the economic consequences of reducing work-hours, exploring the feasibility of the project, and little attention was paid to the effects of worktime reduction on the health of employees. Since 2000, several interventional studies have been published. Therefore, we decided to conduct a review of the literature examining studies focusing on the relationship between reduced working hours and health effects, published since 2000, in which employees retained their salary and proportionally decreased their work time and workload.

METHODS

Search strategy

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist we carried out a literature search for articles published in Medline, PsycInfo, Embase and Web of Science databases from January 2000 up to November 2019. Search terms included terms like “work”, “health”, “well-being”, “mental-health”, “worktime reduction”, “reduced work hours”. Full search strings for each database are provided in supplemental file 1. First, duplicates were excluded. Next, AS, DC, EB and GV independently screened retrieved sources by title and abstract following inclusion criteria. The same authors, always in an independent fashion, performed a full text review. Finally, consensus was reached through discussion about uncertain cases between all reviewers. Authors chose Rayyan QCRI as a tool for selecting and extracting relevant records[15].

Inclusion and exclusion criteria

We decided to include primary sources in any form, both interventional and observational studies, provided that quantitative analysis of any health-related outcome were performed. Hence, studies with qualitative research methods were excluded because we were interested on the effects of the interventions in terms of quantitatively measured outcomes. Articles had to investigate the association between reduced working time with retained salary and health effects, without excluding beforehand any category of workers. No salary reduction was considered crucial in order to avoid a selection bias possibly leading to exclude low-income workers. Another inclusion criterion was the replacement of working activity with any workplace-based intervention, provided that the amount of work hours was effectively reduced. Conversely, studies specifically focused on worktime reduction policies regarding activities with excessively long working hours, such as medical residency, were not consistent with the concept of reduced working hours and retained salary and were therefore excluded from our work. No language restriction was set. Due to the heterogeneity in the outcomes evaluated by the studies selected, a meta-analysis of data could not be conducted. Data and information regarding study design, Country, participant characteristics, observation period, intervention description, outcomes measured and results were extracted and synthesized in a systematic literature review.

Quality assessment

The quality of the included studies was assessed using the “Quality Assessment Tool for Quantitative Studies" developed by the Effective Public Health Practice Project (EPHPP)[16]. This quality appraisal tool provides a standardized means to assess study quality and develop recommendations for study findings considering eight components of study methodology: selection bias, study design, presence of confounders, blinding of participants and outcome assessors, validity and reliability of data collection methods and study dropouts and withdrawals. The overall quality of each study is then expressed as weak, moderate or strong. Previous evaluation of the tool has shown it to be valid and reliable[17]. Two reviewers, namely AS and SR, independently performed quality assessment. Discrepancies between the reviewers, such as differences in interpretation of criteria and studies, were resolved by discussion in order to reach consensus.

Patient and Public Involvement

No patient involved. Results will be disseminated throughout conferences and social media in order to enrich public debate on health outcomes of working hours rearrangements.

RESULTS

As results of the bibliographic search, a total of 3876 published articles were identified (**Figure 1**).

[Figure 1].

Duplicates were excluded and remaining 2456 records were reviewed. A full-text review was conducted on 40 articles. Finally, after evaluating the inclusion criteria, 7 articles were selected (1 article was originally added by citation chasing). In total 7 articles, with a longitudinal interventional design, were included in the final analysis[18–24]. A brief summary of included articles is provided in **Table 1.**

The included studies were published between 2001[24]and 2017[18,19,23] and they were performed in northern Europe[18–24]. The sample size ranged from 63 participants[24] to 580 workers[19], mostly from healthcare settings[20–24]. Only one of the included studies enrolled workers from different workplaces in the public sector (Schiller et al. 2017)[19]. All the studies included had a longitudinal design and the observation period was between 12 months[20–22] and 23 months[23]. Although all the studies compared the intervention group to a control group with no work-time modifications, the intervention exanimated were different. In particular, two studies assessed a work-time reduction to 6 hours per day[22,23], two studies evaluated a weekly work-time reduction of 25%[18,19], two studies evaluated simultaneously a reduced weekly work-time reduction proportionally to the amount of time worked (reduced work hours group) and a 2.5 hours per week physical activity instead of work time program (physical exercise group)[20,21] and one study assessed a reduced weekly work-time reduction from 39 to 30 hours per week[24]. The included studies assessed a variety of different outcomes. In particular general symptoms[20,23,24], neuro-psychological symptoms[18,23,24], working life quality[18,20–24], quality of life[18,23,24], physical activity [20,23,24], sleep [18,19,23,24], musculoskeletal disorders[20,22,23] and biological markers[20] were assessed. After quality assessment phase, overall quality was found to be strong for three studies[19,20,21], moderate for one study[23] and weak for three studies[22,23,24].

In particular, Åkerstedt and colleagues performed a longitudinal cohort study in 5 different healthcare settings, in order to compare the effects of work-hours reduction among health care and day care nursery personnel[24]. The study involved a total of 63 nurses, 41 in the experimental group, a 9 hours reduction of the working week from 39 hours per week to 30 hours, retaining full pay, and 22 in the control group. The experimental group showed a significant improvement for heart/respiratory symptoms, mental fatigue, sleep quality, time for social, time for family/friends, influence on work-hours and satisfaction with work-hours. Additionally, most of these variables also showed a significant change over time. Furthermore, there was a positive change over time for pain/ache complaints, nervous symptoms, gastrointestinal complaints, insomnia complaints, refreshed at awakening, sleepiness at work/leisure time, involuntary sleep at work and leisure time and satisfaction with the work situation. On the contrary, no significant interaction was found between reduced work hours and exercise, weight and BMI[24].

Similar results were published by Barck-Holst and colleagues[18]. They performed a longitudinal quasi experimental study involving seven public social service agencies. Employees in the intervention group reduced their work hours by 25% but retained their previous salary and their organizations were fully reimbursed and staff to compensate the loss of work hours was hired. After controlling for baseline values, gender and age, there was a significant difference in change over time between intervention and control group during workdays on the restorative sleep index, average stress level, the stress index, the memory difficulties index, the negative emotion index, average sleepiness and the fatigue and exhaustion index[18].

Table 1. Characteristics of the studies included in systematic review.

Author	Study Design	Country & Participants	Observation period	Intervention description	Outcome (measures)	Results	Quality assessment rating
Akersredt et al, 2001[24]	Longitudinal intervention study	Sweden, N = 63, full-time workers in health care service.	36 Months	Intervention group (N=41): reduced WWH from 39 hrs/week to 30 hrs/week. Control group (N=22): unchanged working time.	– **General symptoms**, – **neuro-psychological symptoms**, – **working life quality**, – **quality of life**, – **physical activity**, – **sleep**	Subjective sleep quality (SSQ), mental fatigue and heart/respiratory symptoms, time for social activity, time for family and friends improved significantly more in the experimental group than in the control group. No significant effects for sickness absence or self-rated health.	Weak
Wergeland et al, 2003[22]	Longitudinal intervention study	Norway and Sweden, N = 403. Workers in nursing homes, home care services and kindergartens	12-22 Months	Intervention group: reduced DWH to 6 hrs/day. Reference group: unchanged working time.	– **Musculoskeletal disorders**, (shoulder-neck and back pain frequency and work-related physical exhaustion) – **working life quality**	A significant interaction was found for neck-shoulder pain and for exhaustion after work in the intervention group. No significant effects were observed in the reference group.	Weak
von Thiele et al, 2008[20]	Longitudinal intervention study	Sweden, N = 177 employees from 6 workplaces at public dental health care organization	12 Months	PE group: 2.5 hrs/week of physical activity instead of work time. Reduced work hours group: reduced WWH proportionally to the amount of time worked. Reference group: unchanged working time.	– **General symptoms**, – **musculoskeletal disorders**, – **working life quality** (work-home interference, recovery from work and work ability), – **physical activity** – **biological markers** (blood lipids, neuroendocrine markers, cardiovascular measures)	Physical activity level increased in all three groups but significantly more in PE group. Glucose levels and upper-extremity disorders were found to be significantly decreased in the exercise group, while a significant increase in HDL and waist-to-hip ratio was found among those working reduced hours. Participants working reduced hours also had significantly increased total cholesterol, while no changes in LDL-to-HDL ratio were recorded.	Strong
von Thiele et al, 2011[21]	Longitudinal intervention study	Sweden, N = 177 employees from 6 workplaces at a public dental health care organization	12 Months	PE group: 2.5 hrs/week of physical activity instead of work time. Reduced work hours group: reduced WWH proportionally to the amount of time worked.	– **On-the-job productivity**, – **working life quality** (sickness presenteeism and sickness absenteeism) – **Objective production levels** (administrative records)	Physical activity was significantly associated with an increase in self-rated productivity in terms of increased quantity of work and work-ability and decreased frequency and number of days of sickness absence. No effect was found in the work hours reduction group. In all three groups there was an increase in the number of treated patients per	Strong

				Reference group: unchanged working time.		therapist, significantly greater in the reduced work hours group.	
Barck-Holst et al, 2017[18]	Longitudinal quasi-experimental trial	Sweden, N= 204 A total of 125 participants were deemed as per protocol	18 Months	Intervention group: reduced work hours by 25%. Reference group: unchanged working time.	– **Neuro-psychological symptoms** – **working life quality** (demands, control, social support, instrumental manager support, instrumental coworker support, work intrusion on private life) – **sleep**	The intervention group significantly improved restorative sleep, stress, memory difficulties, negative emotion, sleepiness, fatigue and exhaustion on both work days and weekends. Improved demands, instrumental manager support and work intrusion on private life were observed to be significantly higher in the intervention group.	Moderate
Lorentzon 2017[23]	Longitudinal intervention study	Sweden, N = 124, nurses working in a centre for the elderly	23 Months	Intervention group: work-time reduction to 6 hrs/day. Reference group: unchanged working time.	– **General symptoms**, – **musculoskeletal disorders**, – **neuro-psychological symptoms** (alertness level, perceived fatigue, energy left at home, feeling calm, perceived stress), – **working life quality** (collaboration and personal development, sick leaves), – **physical activity** – **sleep**	Good perceived health and alertness level, satisfactory level of perceived fatigue. Energy left at home, feeling calm, satisfactory levels of stress, average sleep time increased in intervention group. General symptoms, sleep and musculoskeletal symptoms improved in the intervention group, and dropped in the control group. Collaboration and personal development improved; improved sense of collaboration between nurses. Sick leave increased in the intervention group. No inferential statistics provided.	Weak
Schiller et al, 2017[19]	Longitudinal controlled intervention study	Sweden, N=580, workers from 33 workplaces in the public sector	18 Months	Intervention group: reduced WWH by 25%. Reference group: unchanged working time.	– **Sleep** – **perceived stress**, feeling of worries	On workdays, the intervention group displayed significantly improved SSQ, decreased sleepiness and perceived stress, less feelings of worries and stress at bedtime when work hours were reduced. Also, a significant 23 minutes extension of sleep duration was detected. The intervention showed similar positive effects on days off, except for sleep duration.	Strong

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In addition, a longitudinal controlled intervention study evaluating a 25% reduction of weekly work hours was published in 2017 by Schiller and colleagues. In this paper, participants worked at 33 different workplaces, in four sectors: social services (n=170); technical services (n=236); care and welfare (n=159); call-center (n=71). The intervention group (n=370) reduced work-time to 75% with preserved salary during 18 months. Data were collected at baseline (1–2 months before the intervention) and approximately 9 months and 18 months after the introduction of reduced work hours. On workdays, the intervention group (N=354) displayed improved subjective sleep quality, 23 minutes extended sleep duration (over the whole period of 18 months), decreased sleepiness and perceived stress and less feelings of worries and stress at bedtime when work hours were reduced (p<0.002). Gender, age, having children living at home, and baseline values of sleep quality and worries and stress at bedtime, considered as additional between-group factors, did not influence the results significantly[19].

Similar outcomes were assessed in a cohort study, performed between February 2015 and December 2016 by Lorentzon and colleagues[23]. In this paper, 68 nurses from the intervention group had their working time reduced to 6 hours per day with retaining their full-time pay. On the contrary, nurses in the control group (N=56) had no working hours reduction. Outcomes were assessed using several questionnaires before, during and after the experimentation. In particular, the sick leave was 6.1% in the intervention group and 12.3% in the control group. Furthermore, health perceived as good (72% vs 60%), alertness level perceived as good (65% vs 50%), satisfactory level of perceived fatigue (+20% vs -22%), feeling having a lot of energy left when arriving at home (51% vs 7%, both starting from 20%), feeling calm (64% vs 45%), satisfactory levels of stress (+20%, -5%), average sleep time (7 hours vs 5.8 hours) had better values in the intervention group compared to the control group. Additionally, in the intervention group, satisfaction regarding physical activity increased (+7% vs -15%). Finally, general symptoms, sleep and symptoms affecting the musculoskeletal system improved in the intervention group, and dropped for the control group[23]. Unfortunately, no statistical inference was provided by Authors.

Similarly, a previous paper assessing the occurrence of musculoskeletal disorders in the experimental and control groups was published by Wegerland and colleagues[22]. In their longitudinal intervention study, involving subjects enrolled from different institutions, workers in the experimental group had their daily work-hours reduced to 6 hours, with retained salary and extra personnel employed to compensate for the reduction in work-hours. Participants were involved through a self-administered questionnaire about pain in the neck-shoulder and back regions prior to and during the work-time reduction. By using a multivariable analysis on data from all the institutions, authors found a significant interaction for neck-shoulder pain (p=0.034) and exhaustion after work (P=0.009). No significant interaction was found for back pain. Additionally, the intervention group showed increased job satisfaction after the reduction in work-hours[22].

Finally, von Thiele and colleagues performed two longitudinal studies in Stockholm, Sweden, involving employees from six workplaces in a large public dental health care organization, randomly allocated to one of three groups: physical-exercise group (PE), reduced work-hours group (RWH), and reference group (R)[20,21]. At the two workplaces acting as reference, no intervention was carried out; at the two workplaces in the PE group, 2.5 hours of weekly work hours were allocated to mandatory physical exercise on two different days; at the two workplaces in the RWH group, full-time weekly hours were reduced from 40 hours/week to 37.5 hours/week. All employees in the intervention groups retained their salaries, and no additional personnel were employed. The final sample consisted of 177 employees, mainly women. Participants were instructed to complete self-ratings at baseline, after 6 months and after 12 months[20,21].

In the paper published in 2008[20] blood samples were and questionnaire were used to explore the areas of physical activity, recovery from work stress, work-home interference, self-related health, work ability, general and musculoskeletal symptoms. The results showed a significant increase in physical exercise in all three groups over time, with post-hoc tests

showed that the increase in the PE group was significantly greater than in the other two groups. Additionally, the analysis showed increasing levels of all of the blood lipids in the reference group (p<0.001, for total cholesterol; p=0.016, for triglycerides; p=0.003, for HDL; p<0.001, for LDL). In the RWH group, total cholesterol and HDL had increased significantly (p=0.019, for total cholesterol; p=0.016, for HDL), while only total cholesterol had increased significantly in the physical-exercise group (p=0.018). Glucose showed a significant time × group effect (p=0.04), and a significant decrease in the PE group (p=0.036). Work ability decreased in the reference group (p=0.005); similar results were found for general symptoms[20].

In the paper published in 2011[21], three outcomes were measured: on-the-job productivity, measured with a single item asking the respondents to rate their current work ability as compared with their individual best work ability on a ten-point scale; sickness presenteeism and sickness absenteeism, assessed with three questions; objective production levels, in terms of the number of treated patients and the number of therapists per month for each participating worksite as well as for all worksites combined. The results showed a significant increase in self-rated quantity of work (p = 0.029) and work ability (p=0.046) in the PE group. Work ability decreased significantly in the reference group (p = 0.004). In the PE group, frequency of sickness absence (p=0.037) and sickness duration (p=0.029) decreased significantly. In the reference group changes in sickness absence duration (p=0.041) and sickness presenteeism (p=0.028) were each significant[21].

DISCUSSION

The purpose of this review was to analyze the results of studies conducted in order to explore the consequences of work time reduction on health outcomes, which is an emerging and debated issue especially in western countries with a developed welfare system, as the ones in Northern Europe. Unfortunately, there is no standard health outcome in the literature that can be used as a comparison in all studies to investigate the effects of reducing working hours on workers' health such as self-perceived health and well-being. Then, we analysed 7 published articles exploring several different health outcomes, and all of them were investigated and discussed.

General and physical symptoms

Four longitudinal studies analysed the relationship between work-time reduction and a broad spectrum of general and physical symptoms. Åkerstedt et al.[24] found a significant improvement of hearth/respiratory symptoms in the experimental group compared to the control group. However, when self-rated health was explored as an outcome, they did not find any statistically significant differences before and after the intervention, neither between the experimental and the control group, nor over time among the same group. Similar results were obtained by von Thiele et al., which did not find any significant differences between the intervention and the reference group regarding neither general symptoms nor self-rated health[20]. As the Authors suggest, the lack of significant results could be explained by the fact that the study was carried out on healthy subjects, consequently reducing the effect size, especially for self-ratings. On the other hand, Lorentzon et al. found an improvement in perceived health in the intervention group compared to the control group[23]. Wergeland et al., in their three-project study, found a significant reduction of neck/shoulder and back pain prevalence in the intervention group[22], in agreement with Lorentzon et al.[23], possibly due to a reduction of time spent in the sitting position during work-time.

Data are still contradictory and it is possible to hypothesize that the real impact of workload reduction on general and physical symptoms, despite having a possible effect on specific physical symptoms, remains to be determined through further larger studies.

Neuro-psychological symptoms

Four studies evaluated the relationship between work-time reduction and neuro-psychological symptoms [18,19,23,24]. General stress was the most frequently explored outcome. Barck-Holst et al. found an average stress level and a stress index significantly decreased in the intervention group, but this difference was higher on workdays compared to weekends[18]. This is consistent with the results of Schiller et al., who found a significant reduction of stress both during the day and at bedtime in the intervention group[19]. Lorentzon et al. found that workers with reduced work-time reported satisfactory levels of stress and perceived fatigue more often in comparison with workers in the control group[23]. Åkerstedt et al. found a significant reduction of mental fatigue in the experimental group[24]. In addition, they found a reduction of nervous symptoms and pain/ache complaints over time, but this difference was not significant between the experimental and the control group. As the authors suggest, the project in itself may have increased the awareness of work organization and health, with positive effects on both groups[24].

Globally, these results suggest that the reduction of work-time is associated with a significant improvement in stress and other neuro-psychological symptoms, probably due to the decrease of workload and the consequent increase of free time for leisure activities.

Sleep

Sleep condition was evaluated in five studies[18–20,23,24]. Åkerstedt et al. and Schiller et al. measured subjective sleep quality (SSQ) using the same items and improvements were observed significantly more in the intervention group than in the reference group[19,24]. Similar results were reported by Barck-Holst et al.[18]. In their study on nurses, Lorentzon et al. found that those nurses working less hours as a part of the experiment averagely slept more than nurses who kept working with regular hours[23]. von Tiele et al. evaluated the presence of sleep disturbances as part of a more comprehensive questionnaire - a modified version of QPSNordic - investigating general symptoms[20,25]. Although they found no improvements in the experimental group regarding general symptoms, we cannot tell whether the occurrence of sleep disturbances taken alone differed among their participants. Despite different measurements being adopted, almost all studies found a significant improvement in sleep among intervention groups compared to control groups. As already reported by previous research, long working hours have shown to negatively influence sleep in many ways[26,27] and this effect may be explained by higher work demands and work-related stress[28]. Thus, we hypothesize that the positive effects of reduced work-time on stress and workload may explain the positive effects on sleep.

Quality of working life

All studies except one investigated whether reduced work hours had measurable effects on working life quality[18–20,22–24]. Åkerstedt et al. found no effects on work demands, but workload had decreased for both intervention and control group[24]. As hypothesized by the authors, it is possible that an increased awareness of work organization following the experiment may be the cause of such findings[24]. No effects on sickness absence were found, as opposed to von Tiele et al., where employees in the intervention group decreased frequency and number of days of sickness absence, as well as perceiving improved self-rated work ability[21]. Other work-related factors were reported as significantly improved after the experiment, including exhaustion after work, sense of collaboration between colleagues, demands, instrumental manager support and work intrusion on private life[18,22,23]. The last finding is in line with results from Anntila et al., in which shorter working hours were associated with positive work-family interaction[29]. Overall, reduced working hours seem to improve working-life quality.

Quality of life

Three studies evaluated the effect of work-time reduction on quality of life outside of work[20,23,24]. Åkerstedt et al. found a significant increase in time for family/friends and social activities in the experimental group, and this increase was significant also over time among the experimental group[24]. However, as mentioned above, they did not find any

improvement in the self-rated health. It is possible that the extra free time, despite exerting a positive effect on general quality of life, does not necessarily determine an improvement in self-perceived health. These results are consistent with the results of von Thiele et al., who did not find any significant differences regarding work-time interaction, neither between the intervention groups and the reference group nor over time among the same groups [20]. In addition, Lorentzon et al. found that healthy behaviors, such as healthy eating, did not improve in the intervention group[23]. Overall, these results suggest that work time reduction per se is not necessarily associated with an improvement in the balance between work and private life. Hence, beside work-time reduction, it is also important to focus on how the extra free time is spent, in order to make the reduction in work-time and workload really effective in exerting positive effects on individual health.

Physical activity

Physical activity was evaluated by three studies[20,23,24]. While Åkerstedt et al. found no significant improvements regarding physical exercise[24], von Thiele et al and Lorentzon et al observed an increase in physical activity in participants experimenting reduced work hours[20,23]. However, the study design by von Thiele et al. consisted in three groups (physical activity group, reduced work hours group and reference group) and such increases were observed in all of them[20]. We do not know whether these changes were a consequence of an increased awareness towards physical exercise brought by the experiment. Moreover, the number of studies evaluating this specific outcome are too few. Although previous research has shown that there seems to be an inverse association between work hours and physical activity[30], for the reasons listed above it cannot be concluded that reduced work hours are associated with increased levels of physical activity. Indeed, we do not know whether employees working for reduced work time would engage their spare time into physical exercise. Hence, more experiments are needed to better determine this subject.

Biological markers

Only von Thiele et al. evaluated the effect of work-time reduction on several biological markers[20]. They found in the reference group increasing levels of all of the blood lipids. In the reduced work hours group, total cholesterol and HDL had increased significantly, while only total cholesterol had increased significantly in the physical-exercise group. Regarding metabolic measures, glucose showed a significant decrease in the physical-exercise group only, while the waist-to-hip ratio increased in the reduced work hours group. These last findings suggest that the work time reduction alone is not sufficient to exert positive metabolic effects, but it should be associated with other healthy habits in the extra free time outside of work, like physical activity. that. On the other hand, in this study the increase of total cholesterol in the exercise group, without any significant reduction in LDL and waist-to-hip ratio, is unexpected and it could be related to other factors, such as diet, which this study did not analyze. Hence, it is impossible to state that a reduction in work hours has a significant and positive effect on biomarkers and metabolic outcomes, and other studies are therefore necessary to clarify these discrepancies.

Strengths and limitations

To date, this is the first literature review carried out in English to establish the relationship between reduced work hours and health effects. Furthermore, our review evaluates the effect of reduced working hours on both self-reported and measured health outcomes. Nevertheless, it has some limitations that must be acknowledged. First of all, the studies we included in our analysis were published in Scandinavian countries, traditionally known for placing a high value on work-life balance. Hence, the results of this review are not easily generalizable in other contexts, which could be different from a social, cultural and economic point of view. Furthermore, even taking into account excluded records, few studies addressed the issue of work time reduction, suggesting that, despite emerging as a relevant topic in public debate over the last few years, the issue of worktime reduction has not been studied enough so far. However, our selection could have missed some relevant studies due to language limitations. In addition, three out of seven studies were evaluated as of

weak quality by the authors. The main reason for this was the impossibility to ensure blinding of both participants and outcome assessors in this kind of studies. Nonetheless all of them had a longitudinal design, over a period of time ranging from 12 up to 36 months. Furthermore, in all studies except two, employment of extra-personnel allowed to prevent a compensatory increase in workload, which could have significantly undermined the effectiveness of worktime reduction. In the end, a great limitation of our review is the remarkable heterogeneity of workers in the seven selected studies. Most of the studies focus on health service workers and this may limit the generalizability of the review to the context of health services that represent a particular work setting with high emotional stress.

CONCLUSIONS

Factors affecting health in the workplace are manifold and include organizational, cultural and social aspects. It is not clear whether changes in working hours alone is a robust enough factor that influences "stress" or other health variables in workers.

However, our review shows that the reduction of work hours is associated with an improvement of sleep habits, lower levels of stress and better working life quality. We did not find a positive influence of work time reduction neither on quality of life outside of work, nor on physical activity. Hence, we can conclude that a reduction of work-hours, with preserved salary and without an increase in total workload, may exert a positive effect on specific health outcomes, especially stress and sleep, but it is also essential to investigate how other work variables such as load, type and organization of work affect the health of the worker. Another important factor that could affect health is how the extra free time is spent. Therefore, further studies are needed to investigate the correlation between different working variables, working time and extra free time with standardized health outcomes in order to evaluate the real impact of working time on workers' health. It is also important to study whether providing prescriptions on how to spend extra free time healthily can improve workers' health. The conflicting results of this review suggest that work time reduction may be truly effective only if it determines a parallel improvement in healthy habits, which can then be main responsible for a real increase of overall health and quality of life.

Data availability

All data relevant to the study are included in the article or uploaded as supplementary information.

Competing interests

The authors declare that they have no conflict of interest.

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Ethics Statement

For this type of study Ethics Commitee approval is not required.

Contributorship Statement

The review was conceived by GV, MRG and RS. Data extraction was carried out by GV, AS, DC, SR and EB with support from MRG, FB and RS. Reporting of findings was led by GV and MRG with support from FB and RS. All authors contributed to manuscript preparation and approved the final version.

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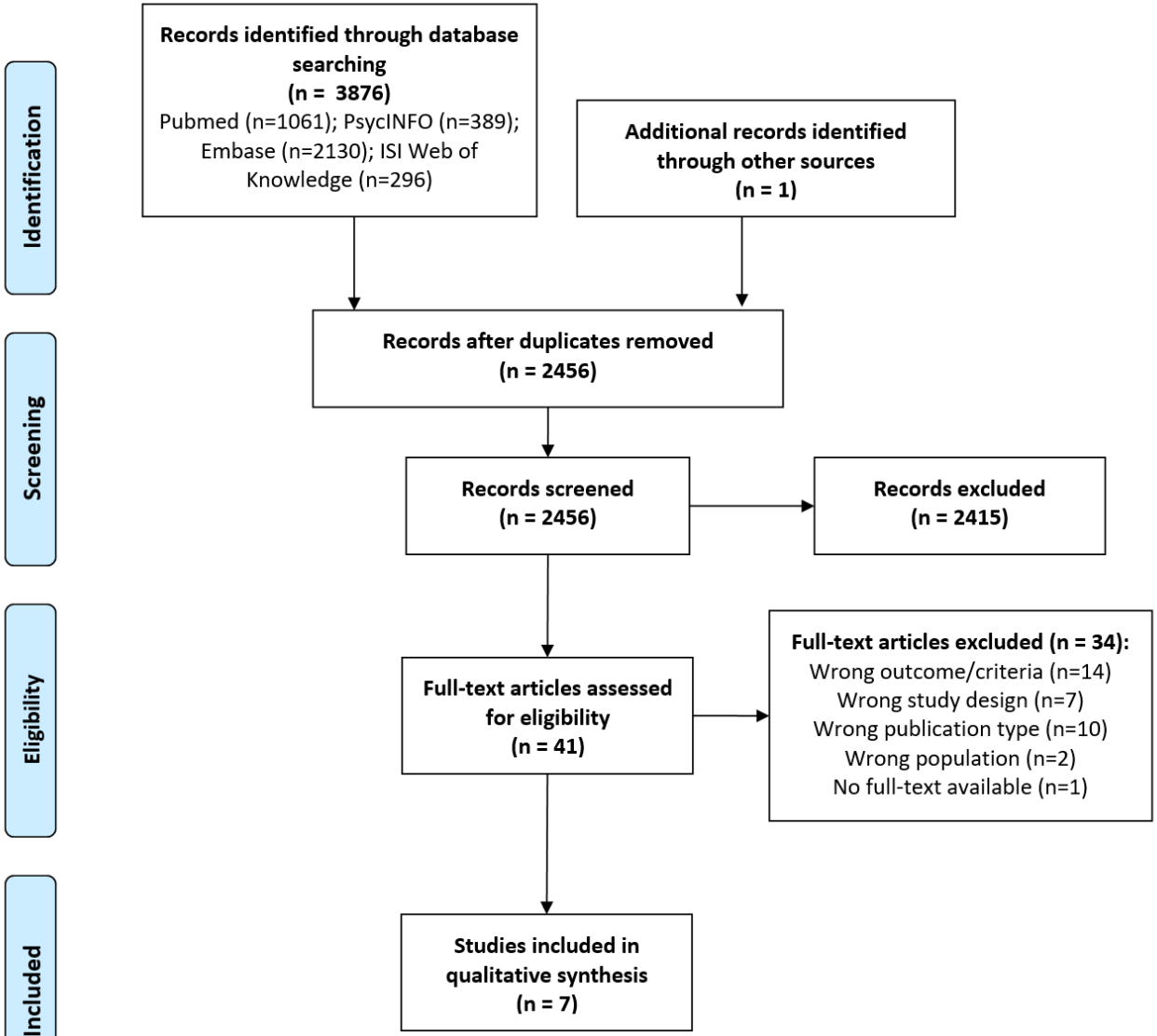
Figure Legends

Figure 1 Systematic review: selection process. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta- Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

Table 1 Characteristics of the studies included in systematic review.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 3876)
Pubmed (n=1061); PsycINFO (n=389); Embase (n=2130); ISI Web of Knowledge (n=296)
Additional records identified through other sources (n = 1)
Records after duplicates removed (n = 2456)
Records screened (n = 2456)
Records excluded (n = 2415)
Full-text articles assessed for eligibility (n = 41)
Full-text articles excluded (n = 34):
Wrong outcome/criteria (n=14)
Wrong study design (n=7)
Wrong publication type (n=10)
Wrong population (n=2)
No full-text available (n=1)
Studies included in qualitative synthesis (n = 7)

Supplemental File 1: search strategies

MEDLINE

("work"[Mesh] OR “Employment”[Mesh] OR work* [Tiab] OR “Employment”[Tiab])

AND

("Mental Health"[Mesh] OR "Occupational Health"[Mesh] OR "Quality of Life/psychology"[Mesh] OR "Occupational Diseases"[Mesh] OR “quality of life”[Tiab] OR "stress" [Tiab] OR "Mental Health" [Tiab] OR "Occupational Health" [Tiab] OR “sleep” [Tiab] OR “health” [Tiab] OR “mental disorders” [Tiab] OR “psychological disorders” [Tiab] OR “insomnia” [Tiab] OR “well-being” [Tiab] OR “anxiety” [Tiab] OR “depression” [Tiab] or “depressive disorder” [Tiab])

AND

(“worktime reduction” [Tiab] OR “reduced workhours” [Tiab] OR “reduced working hours” [Tiab] OR “weekly work hours” [Tiab] OR “weekly working hours” [Tiab] OR “shorter workday”[Tiab] OR “6-hour working day” [Tiab] OR “reduced work hours”[Tiab] OR “reduced worktime”[tiab] OR “work week” [Tiab] OR “workday” [Tiab])

PsycINFO

(DE "Work Load" OR DE "Work Scheduling" OR DE “Workplace intervention” OR TI “work” OR AB “work”)

AND

(DE “Mental Health” OR DE “Occupational Health” OR DE “Mental Disorders” OR DE “Occupational Stress” OR DE “Quality of life” OR TI “Stress” OR AB “Stress” OR TI “Mental Health” OR AB “Mental Health” OR TI “Occupational Health” OR AB “Occupational Health” OR TI “sleep” OR AB “sleep” OR TI “health” OR AB “health” OR TI “mental disorder*” OR AB “mental disorders” OR TI “psychological disorders” OR AB “psychological disorders” OR TI “insomnia” OR AB “insomnia” OR TI “well-being” OR AB “well-being” OR TI “anxiety” OR AB “anxiety” OR TI “depression” OR AB “depression” OR TI “depressive disorder” OR AB “depressive disorder”)

AND

(TI “worktime reduction” OR AB “worktime reduction” OR TI “reduced workhours” OR AB “reduced workhours” OR TI “reduced working hours” OR AB “reduced working hours” OR TI “weekly work hours” OR AB “weekly work hours” OR TI “weekly working hours” OR AB “weekly working hours” OR TI “shorter workday” OR AB “shorter workday” OR TI “6-hour working day” OR AB “6-hour working day” OR TI “reduced work hours” OR AB “reduced work hours” OR TI “reduced worktime” OR AB “reduced worktime” OR TI “work week” OR AB “work week” OR TI “workday” OR AB “workday”)

EMBASE

('work'/exp OR work*:ti,ab,kw OR ‘employment’/exp OR ‘employment’:ti,ab,kw)

AND

('mental health'/exp OR 'occupational health'/exp OR ‘quality of life’/exp OR ‘occupational disease’/exp OR ‘quality of life’:ti,ab,kw OR ‘stress’:ti,ab,kw OR ‘Mental Health’:ti,ab,kw OR ‘Occupational Health’:ti,ab,kw OR ‘sleep’:ti,ab,kw OR ‘health’:ti,ab,kw OR ‘mental disorders’:ti,ab,kw OR ‘psychological disorders’:ti,ab,kw OR ‘insomnia’:ti,ab,kw OR ‘well-being’:ti,ab,kw OR ‘anxiety’:ti,ab,kw OR ‘depression’:ti,ab,kw OR ‘depressive disorder’:ti,ab,kw)

AND

(‘worktime reduction’:ti,ab,kw OR ‘reduced workhours’:ti,ab,kw OR ‘reduced working hours’:ti,ab,kw OR ‘weekly work hours’:ti,ab,kw OR ‘weekly working hours’:ti,ab,kw OR ‘shorter workday’:ti,ab,kw OR ‘6-hour working

day':ti,ab,kw OR 'reduced work hours':ti,ab,kw OR 'reduced worktime':ti,ab,kw OR 'work week':ti,ab,kw OR 'workday':ti,ab,kw)

WEB OF SCIENCE

(job OR work*OR Employment)

AND

("quality of life" OR "stress" OR "Mental Health" OR "Occupational Health" OR "sleep" OR "health" OR "mental disorders" OR "psychological disorders" OR "insomnia" OR "well-being" OR "anxiety" OR "depression" OR "depressive disorder")

AND

("worktime reduction" OR "reduced workhours" OR "reduced working hours" OR "weekly work hours" OR "weekly working hours" OR "shorter workday" OR "6-hour working day" OR "reduced work hours" OR "reduced worktime" OR "work week" OR "workday")

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	p.1 line 4
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p. 3 lines 97-119
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p. 4 lines 119-121
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p. 4 lines 135-147
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p. 4 lines 126-128
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	p. 4 lines 128-133
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p. 4 lines 128-133
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p. 4 lines 145-147
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	p. 11 lines 171-173
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	pp. 10-11 lines 162-171
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	pp. 12-13 lines 247-255
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	pp. 4-12 lines 150-245
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	p. 4 lines 135-147
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	p. 5 lines 157-158

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p. 5 lines 157-158
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	p. 5 lines 155-157
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	/
Study characteristics	17	Cite each included study and present its characteristics.	pp. 11-12 lines 174-245
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	pp. 5-10 Table 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	pp. 5-10 Table 1
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	pp. 5-10 Table 1
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	pp. 13-15 lines 265-352
	23b	Discuss any limitations of the evidence included in the review.	p. 15 lines 356-369
	23c	Discuss any limitations of the review processes used.	p. 15 lines 361-362
	23d	Discuss implications of the results for practice, policy, and future research.	pp. 15-16

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
			lines 372-386
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	N/A
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	N/A
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p. 16 line 392
Competing interests	26	Declare any competing interests of review authors.	p. 16 line 389
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	p.4 line 129

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

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