

Shift work, overweight and obesity in health professionals: a systematic review and meta-analysis

R. Saulle, M. Bernardi, M. Chiarini, I. Backhaus, G. La Torre

Department of Public Health and Infectious Diseases, Sapienza University of Rome, Italy

Abstract

Shift work may have significant repercussions on the health of the worker, and has been linked to unhealthy lifestyles. The aim was to conduct a systematic review of the literature and to assess the relationship between night shift and overweight and obesity among health professionals. A literature search was performed using PubMed and Scopus. The keywords used included: "shift work", "night work", "obesity", "overweight", "nurses" "doctors" "physicians". The whole process of revision followed the PRISMA Statement. Two researchers independently, reviewed the search results, assessed the quality and extracted data. Six transversal and a cohort studies were found for the population of nurses. The meta-analysis did not produce significant results on the prevalence of obesity in the population of nurses (OR: 1.00; 95% CI 0.66-1.50). More high-quality studies and including a larger number of participants should be conducted, in order to assess whether there is real cause-effect relationship between the exposure to night shifts and weight gain as well as of obesity. *Clin Ter* 2018; 169(4):e189-197. doi: 10.7417/CT.2018.2077

Key words: Shift work, overweight, obesity, healthcare professional, systematic review, meta-

Introduction

The Legislative Decree no. 66 of 8.4.2003, defines shift works as a method of organizing work in which several workers are employed at a different times, including the rotational pace, which may be continuous or discontinuous, and that involves the need for workers to work at different hours over a specified period of days or weeks (1).

Hence, shift work can be understood as a type work organization that is different from a normal day-to-day work, and where the company's operating time is extended beyond the regular 8-9 hours of daytime, but covers the entire 24-hour arc by shifting around different working groups.

In the past, shift and night work was considered solely as an organizational method work performance in order to ensure that essential social services as well as hospital care are available.

However, over the years and with the development of society, this type of work has been considered a strategic choice that supports productivity. Shift work plays a significant role in the life and lifestyle of healthcare workers as it can modify and cause the onset of pathologies and can lead to an alteration of physical and psychological well-being.

In fact, shift work can desynchronize the workers general life rhythms and alter the physiological rhythms of their body. Shifts and turns have a strong impact on all aspects of a worker's life, including a change of eating habits, physical activity, circadian rhythms as well as other various types of behavior.

Epidemiological studies have highlighted that an unhealthy lifestyle involves a higher risk of undesirable health effects and the incidence of various pathologies including cardiovascular and metabolic disorders. A study conducted in Norway confirmed that night shift in healthcare facilities is a potential risk factor (2).

Gu et al. demonstrated that a modification of regular sleep patterns, even if for a limited period of time, may unfavorably affect the health of an individual and may increase the risk of cardiovascular disease, including an overall increase of mortality of 11%. In particular, the researchers explored that women who had worked in shifts for a period of 6 to 14 years had a greater risk of dying from cardiovascular disease with more than 19% and even reaching 23% when working in shift for more than 15 years (3).

In line with the above, the study conducted by Huth et al. has shown that poor sleep quality is a predictor of health risks in general (4). Buxton et al. pointed out that a reduced nighttime rest for prolonged periods with concurrent circadian disruption significantly decreased the resting metabolic rate (baseline energy consumption), and increased blood glucose levels (as a consequence of an inadequate response to insulin after a meal), and could therefore increase the risk of obesity and diabetes (5). Nevertheless, also other factors including psychosocial stress, physical inactivity, can contribute to altering metabolism (6).

Shift work also has effects on the mental health with a great tendency to occur in neuropsychological disorders such as mood swings, anxiety and nervousness.

In addition, to the problem of circadian rhythms, shift work may also change the dietary behavior of a professional since those who work in shift are more likely to consume snacks rather than full meals. In fact, factors that may have a particular effect on the diet include: a lack of routine meals with family and friends, eating on their own, the amount of food and canteens. Especially, during a shift work a meal is often not considered a priority and maybe affected by time and staff issues (6,7).

The deteriorating of lifestyles related to increased sedentary and poor eating habits, with the loss of regularity and poorer quality of meals, influences the obesity risk. Therefore, it is important to identify workplace corrective lines for the promotion of healthy lifestyles of workers subject to stressful workloads, such as those who face multiple restless nights several times a month (8).

Objective

The objective of this study was to conduct a systematic review of the literature to assess the relationship between night work and overweight/obesity among health professionals.

Materials and Methods

Literature search and identification of studies.

The literature search was performed using Pubmed and Scopus. The keywords and search terms used were ("shift work" OR "night work") AND ("obesity" OR "overweight") AND "Nurses" ("Shift work" OR "night work") AND ("obesity" OR "overweight") AND doctors.

Quality Assessment and Data extraction

All studies evaluating the association between overweight/obesity and night shift were selected.

The systematic review was performed in line with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (9). Studies were assessed on the basis of their title or abstract. Studies which appeared to meet the eligibility criteria were selected for full text review. Studies that did not include data on overweight/obesity and night shift were excluded. Two researchers performed data selection, extraction and quality assessment independently. Any disagreement between the two researchers was resolved through consensus session with a third researcher. The Newcastle-Ottawa scale (NOS) for observational studies was used to evaluate the quality of the studies (10).

Statistical Analysis

Statistical analysis was performed using the StatsDirect 2.7.8 software. The random or fixed effects model was used based on the Cochran Q value that was used to evaluate heterogeneity between studies in the different groups. I^2 statistic was used to investigate statistical heterogeneity. When the values of Cochran Q were below 0.10 or I^2 was greater than

50%, random effect model was used. Publication bias was investigated using funnel plots.

Results

Characteristics

The initial search yielded 100 articles. 17 articles concerned shift work among doctors and 83 articles dealt with shift work among nurses in healthcare facilities. 46 articles were identified through Scopus and the remaining 54 articles through Pubmed.

The PRISMA diagram for doctors is shown in Figure 1. After reviewing the titles and abstracts, nine articles were excluded. Of the remaining, five articles were excluded after the full text examination. At the end of the selection process, no articles met the inclusion criteria and none were considered as eligible for the review.

As shown in figure 2, 83 articles were about nurses. After removing 21 duplicates, another 32 articles were excluded after title and abstract screening. 30 articles were evaluated on the basis of full text of which 23 were removed as they did not meet the inclusion criteria. For the analysis a total of seven articles met the predetermined inclusion criteria, including six transversal studies (2,4,8,11–13) and one cohort study (14). No RCT or case-control studies were found.

Cross-sectional studies including nurses

Cross-sectional studies on nurses considered in this review aimed at assessing a wide range of health risks and consequences of night-time work (2,4,8,11–13). These included: weight gain, overweight, obesity and other metabolic pathologies.

Huth et al. focused on nurses employed in a pediatric hospital in North East Ohio. The aim of the study was to examine the relationship between working a day shift or night shift and having an elevated BMI. The study also observed the relationship between quality of sleep among nurses working the day shift and nurses working the night shift to an elevated BMI. A percentage of 27,5% were obese (BMI: 30 or higher). When analyzing the BMI by shift, 39 participants (25,8%) reported a BMI greater than 30. These numbers were significantly lower among participants working during the day with 58 non-shift worker out of 220 (28.9%) reporting a BMI of greater than 30 (4). The study conducted by Kivimaeki et al. (12). included 7037 nurses (5038 trainees, 1999 workers per day) in 21 Finnish hospitals. The study showed that obesity rates were significantly higher in the group of shift workers ($n=4941$, 9.6%) compared to the non-shift workers ($n=1975$, 8.5%) ($p = 0.004$) (13).

Similarly, Griep and colleagues examined the association between years of night work and increase of body mass index increase. The results confirmed that the BMI increases in relation to the years of shift. Whereas for women who did night shifts less than 1 year the BMI was 25,4, the BMI was 25,7 for those women who did night shift for 1 to 9 years, those who worked during the night for 10 years or more

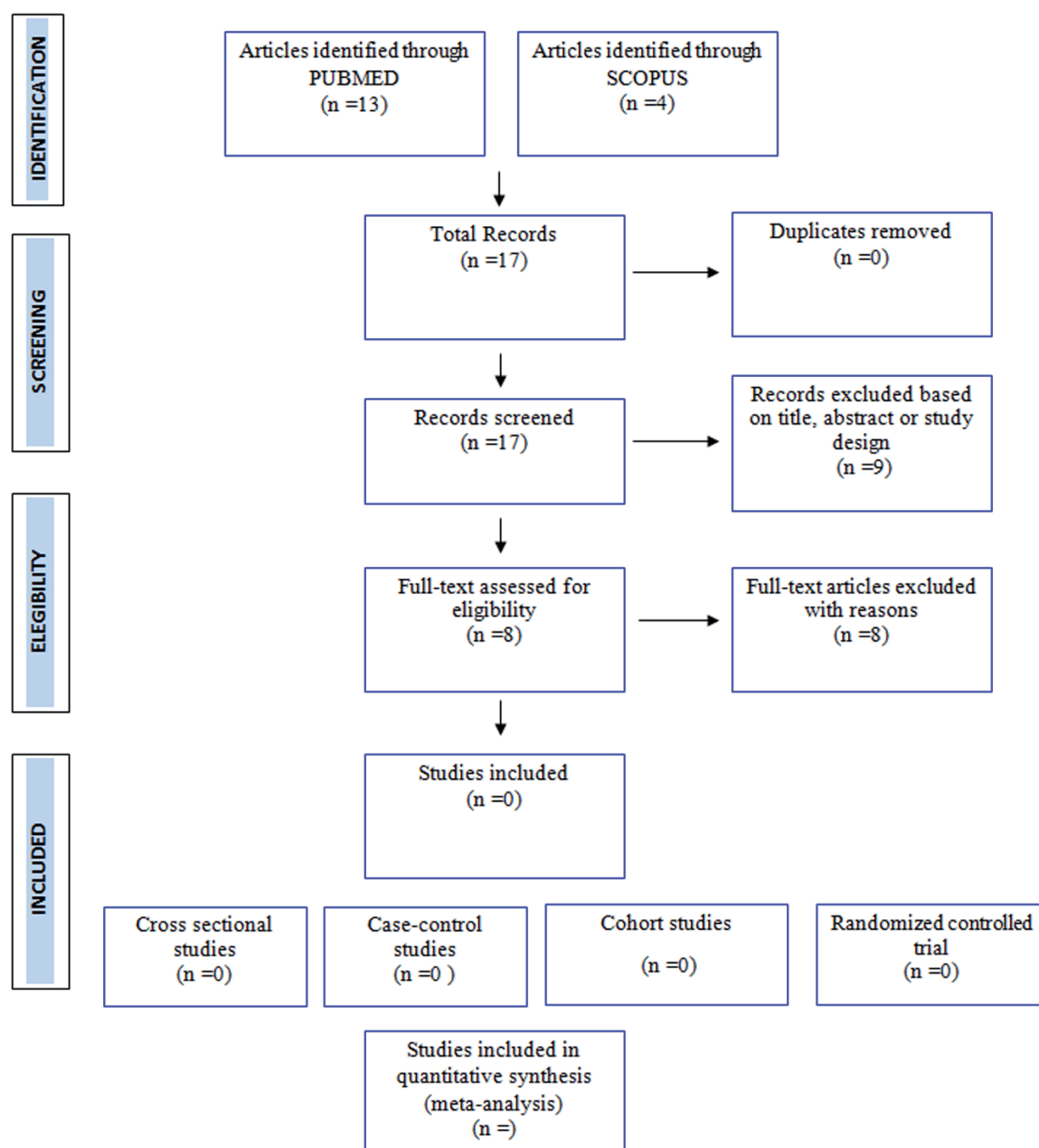


Fig. 1. PRISMA flow chart of the results of the research conducted in May 2016 (physicians)

showed a BMI of 27,2 ($p < 0,001$). These results were also detected for men (BMI: 26,4 for those who did less than 1 year of night work; BMI: 27 for those who did from 1 to 9 years of night work; BMI: 27,9 for those who have spent 10 years or more of night work; $p = 0,099$) (11).

Another study detected an obesity prevalence of 10% in those who made night shifts (568 individuals in total), and 11.7% in those who do more than 30 shifts a night in the last year (631 individuals in total) (2).

A cross-sectional study from Korea, on the contrary, detected that the non-shift work group had a higher BMI

than those who worked at night ($21.4 \pm 2.6 \text{ kg / m}^2$ vs. $20.5 \pm 2.5 \text{ kg / m}^2$, $P < 0.001$) (12).

In non-shift workers a BMI ≥ 25 was found in 428 workers (9.1%) and in 308 (5.8) in turnists, despite the overweight (18.6%) and obesity (7.4%) prevalence over time significantly increased due to the increase in turn-over duration, where prevalence of overweight /obesity (BMI: > 25) was 3.1% (54 individuals in 1732) for a period of less than 3 years of night shift, 4.9% (84 individuals in 1731) for individuals with 3-6. 75 years of night work; 9.6% (162 out of 1686) for individuals with more than 6.75 years of night

work ($p < 0.001$). Overall, all night workers (5287) show a prevalence of obesity of 5.8% (308 individuals) (11).

Chin et al. examined the associations between occupational factors and obesity or physical activity in 394 48-year-old American nurses. 31% of the participants were overweight and 18% were obese, suggesting that occupational factors significantly contribute to the onset of obesity and physical inactivity. Overweight/Obesity was present in 50% (56 out of 118) of shift workers versus 47.6% (120 out of 268) in non-shift workers ($p = 0.675$) (8). The characteristics of the studies are given in detail in Table 1.

Cohort study including nurses

Pietroiusti et al. (14) considered male and female nurses that performed night shifts free from any component of metabolic syndrome (MS) in order to explore whether there is an association between night-shift work and the development of MS. Participants were assessed annually during a 4-year follow-up. The researchers detected a cumulative incidence of MS of 9.0% (36/402) in night shift workers, and 1.8% (6/336) in day workers, and an annual incidence rate of MS of 2.9% in night shift workers and 0.5% in daytime workers. Visceral obesity was more frequent in night-shift workers with 14.2% compared to day-time workers 7.7% (14). R.R. = 1.84, this indicates that the workers exposed to the turnovers have an incidence of obesity equal to twice the unexposed. While IC = 1.18 / 2.85, this indicates that shift work is a risk factor because the coincidence interval is greater than 1 (21). The characteristics of the studies are given in detail in Table 2.

Results of the meta-analysis

Based on the available data, we were able to perform just one meta-analyses, estimating the pooled prevalence of obesity (BMI > 30) in nurses (cross-sectional studies). The analysis showed a non-significant odds ratio value (1.00; 95% IC 0.66-1.50) (Table 3). The plot forrest and the funnel plot are shown in Figure 3 and 4, respectively.

Discussion

Today, the obesity epidemic presents a major challenge to public health. According to the OMS, in 2014, over 1.9 billion adults were overweight or obese (15). Overweight and obesity are related to various pathologies and involve considerable expenditure on health, social and health care. Unfortunately, overweight and obesity are present among healthcare personnel, a population, which should act as healthy role models that follows healthy lifestyle, especially nutrition-related. Cruz-Domínguez M et al. reported a prevalence of 38% overweight and 22% for obesity, among women and men working in the healthcare sector (e.g. doctors, nurses and other health figures) (16).

The present study sought to highlight and summarize data discussing about the prevalence and trends of overweight and obesity among health professionals, such as doctors and nurses. The study specifically, aimed to explore whether doctors and nurses who work at night work are at

greater risk of being overweight or obese compared to those who do not work at night, and are consequently less stressed from an unregularly sleep-wake rhythm.

In fact, it has been pointed out, that the breakdown of circadian rhythms alters metabolism, reducing resting metabolism (baseline energy consumption), and increasing blood glucose levels, resulting in an increased risk for obesity and diabetes. In addition, the modification of lifestyle habits, in particular in terms of hours and quality of meals, affects the risk of obesity (6).

Compared with individuals who work the typical time of 8 hours, those who work in shifts have a greater risk of developing diseases such as type 2 diabetes, cardiovascular diseases, digestive problems, sleep disorders, depression and Vitamin D deficiency (due to reduces exposure to sunlight) as well as obesity (6,7). Research has also revealed that employees who work in shifts are more likely tend to eat snacks and irregular rather than eating regular full meals. In general, lifestyles habits seem to be poorer among shift workers, including a greater frequency of sedentary lifestyle habits, smoking and consuming more psycho-stimulating substances such as caffeine (6).

The cohort study conducted by Pietroiusti et al. presented significantly disadvantageous to the population of night-time shifts where there is an increase in the incidence of visceral obesity, which is about twice the turnover of non-turnists (RR = 1.84, IC 95% = 1.18-2.85). The results of prospective studies in the literature confirm the results of the cohort study conducted by Pietroiusti (21). These studies had the same goal of evaluating the weight-to-weight ratio between night-time workers on different categories of workers (health workers, such as factory workers). The highest quality study design studies, such as cohorts, that analyzed the association between night work and obesity, are all agreed to conclude that night-time use is an important health risk factor, increasing probability to get sick of cardiovascular disease, diabetes, and obesity. Even the correlation is directly proportional to years of work or more years of exposure to night work and the greater the risk of being overweight or obese, as well as of having cardiovascular disease (4,17-21).

Four different cohort studies conducted in Japan all concluded that night-time work was is a risk factor for weight gain/BMI increase (17-19,21,22). In fact, the study of Itani et al. showed the association between shift work, sleep reduction and obesity onset. Kubo et al. found an increase in the risk of becoming obese in those who were exposed to shift work compared to unexposed (RR = 1.14; IC 95% = 1.01-1.28 $p = 0.029$). The study further noted that the risk particularly increased after 10 years of follow-up (17). Another cohort study conducted in 2013 confirmed these findings (HR = 1.15, IC 95% = 1.13-1.17) (18). Suwazono et al. showed that shift work is an independent risk factor for weight gain in Japanese male workers (21).

Lin an colleague, explored that day-night rotating shift work contributed to the progression of MS (OR = 3.5, CI: 1.3-9.0) (20). Similar results were found in a nested case-control study that discovered that night-time workers were more likely to have MS than those not performing night shifts (OR = 1.87; CI95% = 1.13-3.08) (19).

The performed meta-analysis did not produce significant results on the prevalence of obesity in the population

Table 1. Characteristics of cross-sectional studies including nurses

First author, year	Study population	Objective	Results	Conclusion	Quality assessment (NOS score)
Kivimäki, 2006	7037 female nurses (5038, 1999 day workers) in 21 Finnish hospitals.	To examine whether health-related selection out of shift work is likely to bias the association between shift work and cardiovascular disease (CVD).	Among the shift workers obesity rates were significantly higher (n.4941; 9.6%) in comparison day workers (n.1975; 8.5%) (p = 0.004).	Employees with several risk factors are more likely to leave an organization regardless of the type of work schedule.	4
Huth, 2013	Nurses who work in hospitals continue to be one of the main professions that provide 24-hour service by working scheduled shifts	To examine the incidence of elevated BMI in a convenience sample of pediatric nurses; to explore the relationship between working the day shift or night shift and having an elevated BMI; and to determine the relationship between quality of sleep among nurses working the day shift and nurses working the night shift to an elevated BMI	Ninety-seven respondents (27.5% of the sample) had a BMI 30 or greater. The night shift survey results showed that 74.2% (n = 112) of participants had a BMI < than 30, while 25.8% (n = 39) reported a BMI greater than 30.	The study did not determine a significant relationship between the shift worked and an elevated BMI or quality of sleep and an elevated BMI the trending increase in BMI as sleep quality decreases is important when considering the link of an elevated BMI to health risks.	6
Griep, 2014	2,372 registered nurses (2,100 women).	To determine the relationship between the years of exposure to night work and body mass index (BMI) among registered nurses.	The results confirmed that the BMI increases in relation to the years of shift. Whereas for women who did night shifts less than 1 year the BMI was 25.4, the BMI was 25.7 for those women who did night shift for 1 to 9 years, those who worked during the night for 10 years or more showed a BMI of 27.2 (p <0.001). These results were also detected for men (BMI: 26.4 for those who did less than 1 year of night work; BMI:27 for those who did from 1 to 9 years of night work; BMI: 27.9 for those who have spent 10 years or more of night work; p = 0.099)	These findings suggest that night shift exposure is related to BMI increases. Obesity prevention strategies should incorporate improvements in work environments, such as the provision of proper meals to night workers. Educational programs on the health effects of night work.	5
Buchvold Vikanes, 2015	Norwegian nurses	To evaluate the night shift work load effect on BMI, alcohol consumption, smoking habits, caffeine consumption, and exercise habits using the number of night shifts worked the last year as a predictor.	The obesity prevalence was 10% among those who have not done shifts at night, and 11.7% among those nurses worked more than 30 times a year in the last year.	The study found a positive significant association between night work load and BMI. This suggests that workers with a heavy night work load might need special attention and frequent health checks due to higher risk of undesirable health effects.	5
Kim, 2013	9,989 nurses were included among 10,000 who registered on the survey web site (5,287 shift workers and 4,702 non-shift workers)	To investigate the association between current shift work and BMI among female nurses in Korea and to evaluate the relationship between duration of shift work and the BMI.	Mean participant age was 33.2 ± 8.6 years and the mean BMI was 20.9 ± 2.5 kg/m ² . There were statistically significant differences in current smoking status, regular drinking habit, dietary habits, regular exercise, sleep problems and self-perceived health status according to duration of shift work. The prevalence of overweight/obesity (18.6%) and obesity (7.4%) increased significantly as shift work duration increased from the lowest to highest tertile (P for trend <0.001).	The duration of shift work was positively associated with prevalence of overweight/obesity in nurses in Korea. Although these findings need to be confirmed in prospective studies, they suggest that special attention should be paid to female nurses with a long duration of shift work.	6
Chin, 2016	394 nurses (mean age 48 years, 91% females, 61% white) randomly selected from the California Board of Registered Nursing list.	To examine the associations of occupational factors with obesity and leisure-time physical activity among nurses.	Of the participants, 31% were overweight and 18% were obese; 41% engaged in regular aerobic physical activity at least 150 min/week, and 57% performed regular muscle-strengthening activity at least 2 days/week	The findings suggest that occupational factors significantly contribute to obesity and physical inactivity among nurses.	6

Table 2. Characteristics of cohort study including nurses

First author, year	Study population	Objective	Results	Conclusion	Quality assessment (NOS score)
Pietroiusti, 2010	Male and female nurses enrolled during an annual health surveillance program performed by occupational physicians in three large hospitals (two teaching hospitals and one general hospital).	To evaluate whether the performance of night shifts may influence the incidence of MS in male and female nurses.	The cumulative incidence of visceral obesity was 14,2 % (57 /402) in night-shift workers and 7,7 % (26/336) of day worker.	The development of the syndrome is significantly higher in night-shift healthcare workers than in daytime healthcare workers, and suggests a causal relationship between the two events. These findings open the way to similar prospective confirmatory studies in workers involved in other activities, and suggest that appropriate medical surveillance and, if necessary, changes in work schedule should be considered in healthcare workers developing the syndrome.	7

Table 3. Details of the meta-analysis

Stratum	Table (xt, xc, nt, nc)				
1	39	58	112	143	Huth 2013
2	4941	1975	97	24	Kivimaki 2006
3	74	114	557	1314	Buchvold 2015
4	56	120	62	148	Chin 2016
Stratum	Odds ratio		95% CI (CML)		
1	0,858528	0,517311	1,416534	Huth 2013	
2	0,618995	0,37735	0,979328	Kivimaki 2006	
3	1,531324	1,107724	2,106311	Buchvold 2015	
4	1,113978	0,704298	1,759486	Chin 2016	
Stratum	Standardized Effect		Standard Error	% Weights (fixed, random)	
1	-0,152536	2,278315	19,265154	23,187559	Huth 2013
2	-0,479658	1,875814	28,419761	23,976534	Kivimaki 2006
3	0,426133	1,762437	32,193844	28,368456	Buchvold 2015
4	0,107938	2,229321	20,121241	24,467451	Chin 2016

<u>Non-combinability of studies</u>					
Breslow-Day = 11,928263 (df = 3) P = 0,0076					
Cochran Q = 11,751916 (df = 3) P = 0,0083					
Moment-based estimate of between studies variance = 0,127159					
I ² (inconsistency) = 74,5% (95% CI = 0% to 88,8%)					
<u>Random effects (DerSimonian-Laird)</u>					
Pooled odds ratio = 0,996927 (95% CI = 0,663602 to 1,49768)					
Chi ² (test odds ratio differs from 1) = 0,00022 (df = 1) P = 0,9882					
<u>Bias indicators</u>					
Begg-Mazumdar: Kendall's tau = -0,666667 P = 0,0833 (low power)					
Egger: bias = -8,215664 (95% CI = -22,871299 to 6,439972) P = 0,1373					
Horbold-Egger: bias = -8,040446 (92,5% CI = -30,538987 to 14,458094) P = 0,3436					

of nurses (OR: 1.00; 95% CI 0.66-1.50). Therefore, this review confirmed that work night-time increases the risk of becoming obese in the specific population of nurses, in relation to the cohort studies included.

Nothing would, however, suggest that healthcare personnel is different from other working population in terms of weight and obesity, and indeed the healthcare population, having to act as a model for prevention and a pattern of correct lifestyles should be more protected by this condition.

This study has some limitations. First, few primary studies were identified, because of the paucity of data in the literature. The number of studies included in this review in fact is very limited, both for nurses and especially for doctors, because none study satisfied the inclusion criteria. Of these only one study was of good quality (14).

Unfortunately, no clinical trial concerning shift work and obesity among healthcare personnel could be identified.

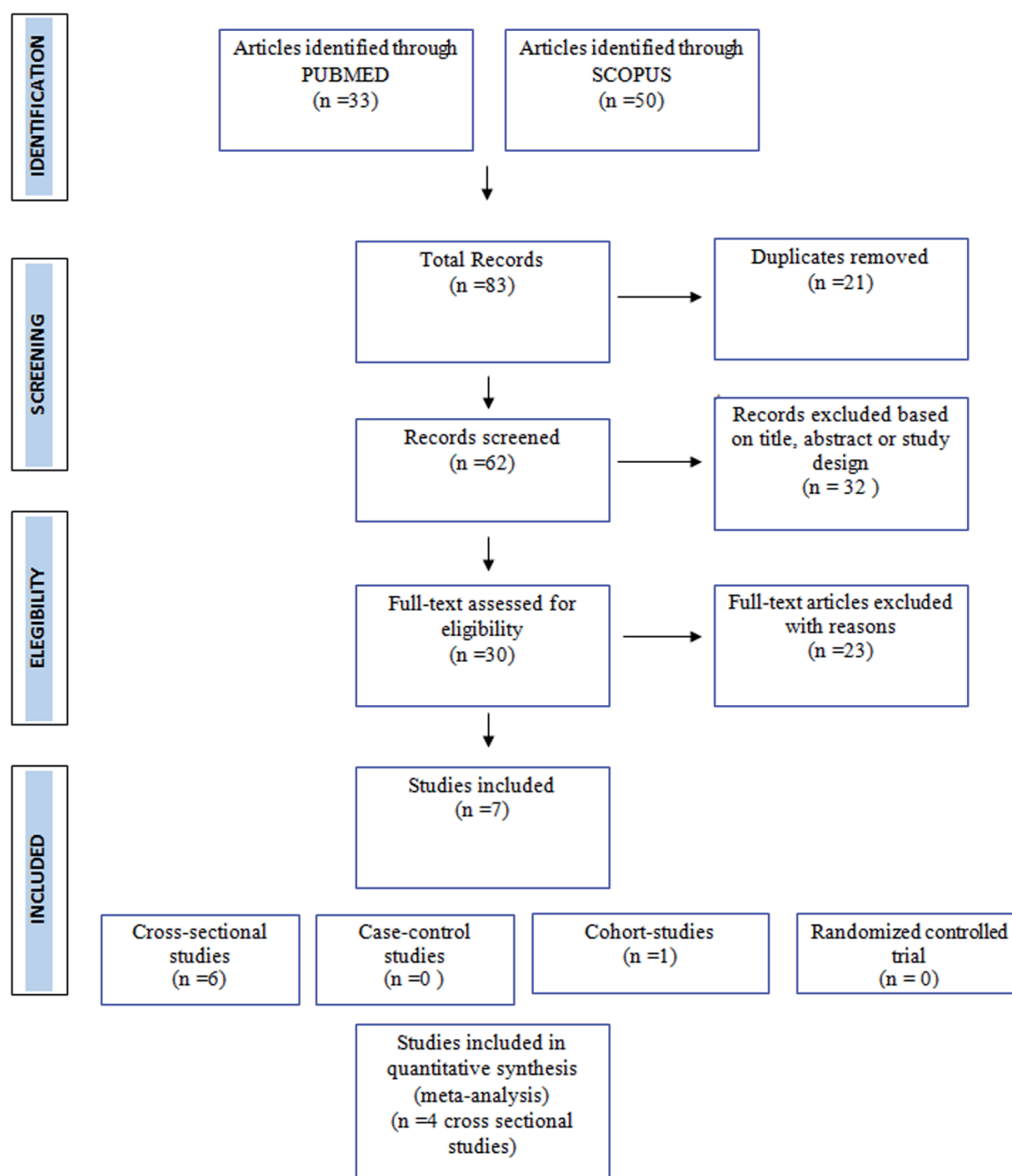


Fig. 2. PRISMA flow chart of the results of the research conducted in May 2016 (nurses)

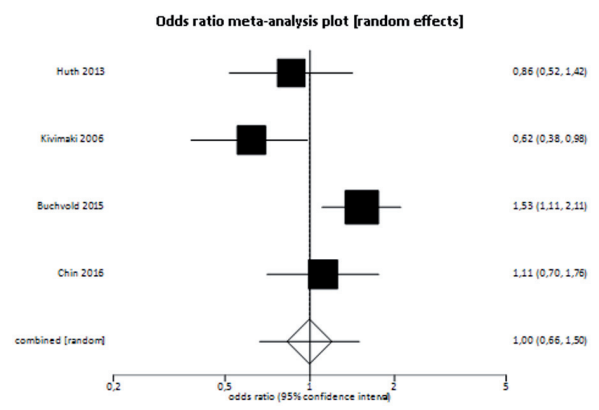
Some studies could not be included in the meta-analysis because they reported data that was not comparable and analyzable with the other studies (9, 11).

In the future we would like to see that high-quality studies, including a large number of participants, are conducted, in order to allow us to determine whether there is a real cause-effect association between the exposure to night work and weight gain, BMI and obesity, respectively.

In any case, it is difficult to formulate dietary recommendations for shift workers, but it is possible to identify

general guidelines for employers and workers to promote healthy lifestyles.

Evidence is there. In a two-arm randomized controlled clinical trial, conducted by Morgan et al. (19), evaluated the effectiveness a dietary treatment at the workplace to reduce weight in male turn-key workers. The program called “Workplace POWER-WP” recruited 110 shift workers who were overweight/obese (BMI 25-40, mean age (SD) = 44.4 years (8.6), BMI = 30.5 (3.6)) (19).



Odds ratio of cross-sectional studies on population of nurses with BMI > 30 (prevalence studies)

Fig. 3. Forrest plot. Dichotomous measure: number of shift workers and not with a prevalence of obesity (BMI > 30)

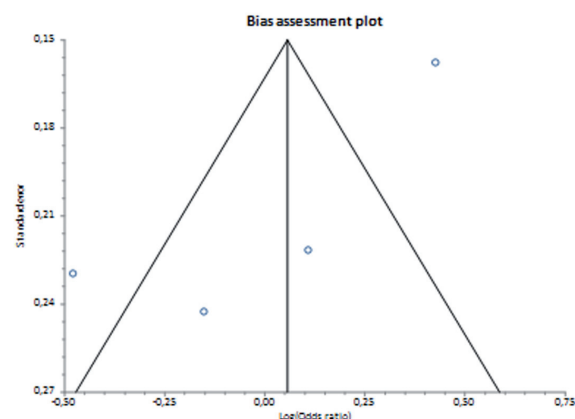


Fig. 4. Dichotomous measure: number of shift workers and not with a prevalence of obesity (BMI > 30)

The 3-month program included information sessions, program booklets, an online component and group-based financial incentives. Men were assessed at baseline and at 14-week follow-up to check their weight (primary outcome), waist circumference, body mass index, blood pressure, resting heart rate, self-reported physical activity and dietary variables as well as physical activity and dietary cognitions, and improved eating habits, especially focusing on the reduction of sugary drinks. The program was found to be effective, feasible and easy to follow, and has quickly led to health improvement in relation to behavioral changes and lifestyles (23, 24).

Conflict of Interest: the authors declare to have no conflict of interest

Financial support: None

References

- Gazzetta Ufficiale Attuazione delle direttive 93/104/CE e 2000/34/CE concernenti taluni aspetti dell'organizzazione dell'orario di lavoro Available online: <http://www.camera.it/parlam/leggi/deleghe/03066dl.htm> (accessed on Sep 4, 2017)
- Buchvold HV, Pallesen S, Øyane NM, et al. F.; Bjorvatn, B. Associations between night work and BMI, alcohol, smoking, caffeine and exercise—a cross-sectional study. *BMC Public Health* 2015; 15, 1112, doi:10.1186/s12889-015-2470-2
- Gu F, Han J, Laden F, Pan A, et al. Total and cause-specific mortality of U.S. nurses working rotating night shifts. *Am J Prev Med* 2015; 48:241–52, doi:10.1016/j.amepre.2014.10.018
- Huth JJ, Eliades A, Handwork C, et al. Shift worked, quality of sleep, and elevated body mass index in pediatric nurses. *J Pediatr Nurs* 2013; 28:e64–73, doi:10.1016/j.pedn.2013.02.032
- Buxton OM, Cain SW, O'Connor SP; et al. Adverse metabolic consequences in humans of prolonged sleep restriction combined with circadian disruption. *Sci Transl Med* 2012; 4:129ra43, doi:10.1126/scitranslmed.3003200
- Lowden A, Moreno C, Holmbäck U, et al. Eating and shift work - effects on habits, metabolism and performance. *Scand. J. Work. Environ. Health* 2010; 36:150–62
- Atkinson G, Fullick S, Grindley C, et al. Exercise, energy balance and the shift worker. *Sports Med Auckl NZ* 2008; 38:671–85
- Chin DL, Nam S, Lee SJ. Occupational factors associated with obesity and leisure-time physical activity among nurses: A cross sectional study. *Int J Nurs Stud* 2016; 57:60–69, doi:10.1016/j.ijnurstu.2016.01.009
- Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J. Clin. Epidemiol.* 2009, 62, e1–34, doi:10.1016/j.jclinepi.2009.06.006
- Wells G, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses Available online: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (accessed on Sep 4, 2017).
- Griep RH, Bastos LS, Fonseca M. et al. Years worked at night and body mass index among registered nurses from eighteen public hospitals in Rio de Janeiro, Brazil. *BMC Health Serv Res* 2014; 14, 603, doi:10.1186/s12913-014-0603-4
- Kim MJ, Son KH, Park HY, et al. Association between shift work and obesity among female nurses: Korean Nurses' Survey. *BMC Public Health* 2013; 13:1204, doi:10.1186/1471-2458-13-1204
- Kivimäki M, Virtanen M, Elovainio M, et al. Prevalent cardiovascular disease, risk factors and selection out of shift work. *Scand. J. Work. Environ. Health* 2006; 32:204–8
- Pietroiusti A, Neri A, Somma G, et al. Incidence of metabolic syndrome among night-shift healthcare workers. *Occup Environ Med* 2010; 67:54–57, doi:10.1136/oem.2009.046797

15. World Health Organization La sfida dell'obesità nella Regione europea dell'OMS e le strategie di risposta 2007
16. del Pilar Cruz-Domínguez M, González-Márquez F, Ayala-López EA, et al. (Overweight, obesity, metabolic syndrome and waist/height index in health staff). *Rev Medica Inst Mex Seguro Soc* 2015; 53:Suppl 1, S36-41
17. Kubo T, Oyama I, Nakamura T, et al. Retrospective cohort study of the risk of obesity among shift workers: findings from the Industry-based Shift Workers' Health study, Japan *Occup Environ Med* 2011; 68:327-331, doi:10.1136/oem.2009.054445
18. Kubo T, Fujino Y, Nakamura T, et al. An industry-based cohort study of the association between weight gain and hypertension risk among rotating shift workers. *J. Occup. Environ Med* 2013; 55:1041-1045, doi:10.1097/JOM.0b013e31829731fd.
19. Li Y, Sato Y, Yamaguchi N. Shift work and the risk of metabolic syndrome: a nested case-control study. *Int J Occup Environ Health* 2011; 17:154-60, doi:10.1179/107735211799030960
20. Lin YC, Hsiao TJ, Chen PC. Persistent rotating shift-work exposure accelerates development of metabolic syndrome among middle-aged female employees: a five-year follow-up. *Chronobiol Int* 2009; 26:740-755, doi:10.1080/07420520902929029
21. Suwazono Y, Dochi M, Sakata K, et al. longitudinal study on the effect of shift work on weight gain in male Japanese workers. *Obes. Silver Spring Md* 2008; 16:1887-93, doi:10.1038/oby.2008.298
22. Itani O, Kaneita Y, Murata A, et al. Association of onset of obesity with sleep duration and shift work among Japanese adults. *Sleep Med* 2011; 12:341-5, doi:10.1016/j.sleep.2010.09.007.
23. Ippoliti F, Corbosiero P, Canitano N, et al. Work-related Stress, over-nutrition and cognitive disability. *Clin Ter* 2017 Jan-Feb;168(1):e42-e47
24. Pancallo MT, Saulle R, Semyonov L, et al. Effectiveness of a protocol treatment for overweight/obese patients (SIAN - ASL RMA). *Clin Ter* 2015; 166(5):e306-11