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Metabolic syndrome in shift healthcare workers

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Parole chiave: Lavoro a turni; lavoro notturno; operatore sanitario; valutazione del rischio; gestione del rischio

Summary

Background: *Shift work including night shifts is generally associated with chronic misalignment between the endogenous circadian timing system and behavior cycles, leading to metabolic disorders including metabolic syndrome (MS).* **Objectives:** *The purpose of this research was to analyze the latest developments in assessing and managing the occupational risk of MS in shift-healthcare workers (HCWs).* **Methods:** *According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, the authors used MEDLINE/Pubmed to perform a systematic review of literature from January 2008 to December 2018.* **Results:** *Six studies were selected; the topics, discussed in order of frequency from highest to lowest, were: risk assessment, occurrence rates, and risk management. The main occupational determinants for MS were the cumulative shift work including night shifts and the number of nights worked per month per worker. With regard to cumulative lifetime exposure to shift work, the findings of our review suggest a dose–response relationship between increasing years of shift work history and MS in shift-HCWs.* **Conclusions:** *The findings suggest the need to better investigate the impact of sleep deprivation in the assessment of MS risk in shift-HCWs and clarify the role of such variables as confounders, mediators, or effect modifiers. Moreover, to date the data regarding management interventions focused on the risk of MS are inconsistent and therefore a special effort is required to detect strategic ways to minimize the likelihood of MS occurring in shift-HCWs.*

Riassunto

***«Sindrome metabolica in operatori sanitari turnisti»*.** **Introduzione:** *Il lavoro organizzato su turni, incluso il turno notturno, è generalmente associato ad un disallineamento dei ritmi circadiani rispetto ai cicli comportamentali, responsabile di disordini metabolici inclusa la sindrome metabolica (SM).* **Obiettivi:** *L'obiettivo della ricerca è stato quello di analizzare i più recenti sviluppi sulla valutazione e gestione del rischio lavorativo di sindrome metabolica tra gli operatori sanitari turnisti.* **Metodi:** *Seguendo le indicazioni del regolamento PRISMA, gli autori hanno condotto una revisione sistematica della letteratura dal gennaio 2008 al dicembre 2018, attraverso la consultazione delle banche dati MEDLINE/Pubmed.* **Risultati:** *Sono stati selezionati 6 articoli. Gli argomenti più frequentemente discussi sono risultati: la valutazione del rischio lavorativo di SM, frequenza della SM e gestione del rischio*

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lavorativo di SM. I principali determinanti occupazionali di SM sono risultati: numero complessivo di turni, inclusi i turni notturni, lavorati nella vita lavorativa e numero di turni notturni mensili. Per quanto riguarda l'esposizione cumulativa al lavoro a turni, la presente ricerca evidenzia una relazione dose-risposta tra l'aumento del numero di turni lavorati ed un maggior rischio di SM. **Conclusioni:** *I risultati suggeriscono la necessità di approfondire l'impatto della deprivazione di sonno nella valutazione del rischio di SM tra gli operatori sanitari turnisti, chiarendo il ruolo di tale variabile quale confondente, mediatore o modificatore di effetto, ancora non chiaro. Ad oggi, inoltre, i dati riguardanti gli interventi gestionali focalizzati sul rischio di SM risultano inconsistenti; pertanto, è richiesta la ricerca di soluzioni strategiche, a livello gestionale, per minimizzare la probabilità di insorgenza della SM tra gli operatori sanitari turnisti.*

Introduction

The prevention of metabolic syndrome (MS) is a special challenge for shift workers employed in 24-hour hospital wards. In fact, literature has increasingly revealed a relationship between shift work, including night shifts, and the disruption of circadian sleep and alert cycles, resulting in metabolic disorders such as MS, a risk condition for ischemic cardiovascular disease and diabetes (7, 12, 21, 26). According to the International Diabetes Federation (2, 8), MS is defined as a clustering of metabolic abnormalities, especially including central obesity (e.g. waist circumference; if Body Mass Index is >30 kg/m^2, central obesity can be assumed and waist circumference does not need to be measured) as a prerequisite and two of the following factors: 1) raised triglycerides; 2) reduced high-density lipoprotein-cholesterol; 3) raised blood pressure (e.g. systolic or diastolic blood pressure); 4) raised fasting plasma glucose. Shift work including night shifts is generally associated with chronic misalignment between the endogenous circadian timing system and behavior cycles (19, 27). This circadian misalignment has been found to result in adverse metabolic and cardiovascular consequences, including a decrease in leptin, an increase in glucose and insulin, an increase in mean arterial blood pressure, reduced sleep efficiency, and, consequently, a significant risk of MS (7, 23). Specifically in relation to healthcare work in 24-hour hospital wards, in which irregular shifts are commonly observed, scientific evidence has shown that this work organization can negatively affect workers both physiologically and psychologically (1). Among the most frequent consequences are sleep disorders, MS, and coronary heart disease and stroke, in addition to work accidents and decreased job performance and job satisfaction (13). The purpose of this review was to evaluate the literature and discover the latest developments in assessing and managing the occupational risk of MS in shift healthcare workers in the last 10 years. For the aims of the present review, shift work was defined as any work schedule in which HCWs work non-traditional shifts, including night shifts.

Methods

Search strategy

We performed an extensive search of literature from Jan. 2008 to Dec. 2018 using MEDLINE/Pubmed. Selected keywords were used to identify articles for the systematic review of literature. The keywords were: Shift Work, Night Work, Healthcare Worker, Metabolic Syndrome, Hospital Ward, Assessment, Management, Occurrence. The keywords were systematically combined in order to conduct the literature search. For example, "Shift Work" AND "Healthcare Worker" AND "Metabolic Syndrome" was one combination. We aimed to identify original research articles (i.e. non-reviews) using the above-mentioned keywords with the following exclusion criteria: (1) not written in English; (2) non-human studies; and (3) not full reports (i.e. letters to the editor).

Data extraction

The screening of articles was carried out in two phases. In the first phase, articles were screened on the basis of title and abstract. The abstracts of all the

selected titles were sorted for more detailed information. Two independent reviewers (G.D. and V.P.) read the abstracts and categorized them as relevant, not relevant, or possibly relevant. In the second phase, the full-text articles were assessed for eligibility. Two reviewers (G.D. and V.P.) independently applied inclusion and exclusion criteria to potentially eligible papers and both reviewers then independently extracted data from the original articles. Any disagreements were independently checked by the second reviewer (M.G.) and a consensus was reached.

Categorization of selected articles

Every full-text article that met the inclusion criteria was reviewed and categorized into one or more of the following three categories based on its subject matter: risk assessment (articles aimed at the identification of occupational risk factors for MS), risk management (articles focused on occupational interventions for reducing the likelihood of MS occurrence), and occurrence rates (e.g. incidence or prevalence of MS among shift-HCWs).

This systematic review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (15).

Results

Our research of the two literature databases resulted in a total of 21 publications that matched our inclusion criteria. Fifteen of these were removed because they were deemed irrelevant (i.e. non-research conference proceedings or not concerning shift-HCWs). Therefore, six papers remained in the study (figure 1). These six papers were then categorized according to their subject matter. The topics, discussed in order of frequency from highest to lowest, were: risk assessment, occurrence rates, and risk management. All six papers focused on risk assessment; five papers focused on occurrence rates; and two focused on risk management. Five papers discussed both risk assessment and occurrence rates and two papers addressed all three topics (table 1).

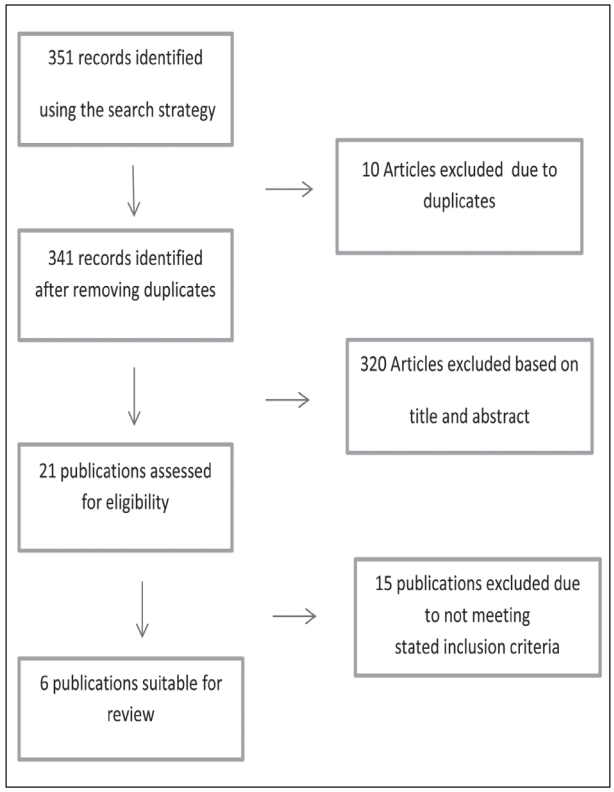

Figure 1 - Flow chart of the search and selection process in the systematic review

Discussion

Risk assessment of MS

The findings of our study suggest that in the last 10 years the main topic of the selected papers focused on risk assessment and aimed to identify the potential hazards for MS in shift-HCWs. Among the six studies that focused on risk assessment, three studies (4, 5, 11) focused on occupational determinants of MS and three (10, 16, 20) investigated both the organizational determinants of MS and the mediator role of individual determinants in the relationship between MS and shiftwork.

Regarding the occupational determinants of MS, we found that cumulative shift work, including night shifts and the number of nights worked per month, were frequently detected as occupational hazards for MS. In particular, in a longitudinal study Pietroiusti et al. (20) demonstrated an increased risk of MS for shift-HCWs working ≥4 night shifts per

Table 1 - Summary of literature review findings and article categorization based on addressed topics and methodological approaches

Author and year	Risk assessment	Risk management	Occurrence rates	Sample size	Study design	Adjustment of covariates
Farha & Alefishat 2018 (5)	X		X	140	Cross-sectional	Age, gender.
Pietroiusti et al. 2010 (20)	X	X	X	738	Longitudinal	Age, gender, smoking, alcohol, sedentariness, family history.
Korsiak et al. 2017 (10)	X	X	X	294	Cross-sectional	Age, menopausal status, sleep duration
Lajoie et al. 2015 (11)	X		X	271	Cross-sectional	Age, household income, menopausal status
Molzof et al. 2017 (16)	X			17	Cross- sectional	Body weight
Copertaro et al. 2008 (4)	X		X	147	Cross-sectional	Age, gender, smoking

month. After four years, the relative risk (RR) of developing MS was 5.0 (95% confidence interval (CI) 2.1 to 14.6). These findings that support the mediation of cumulative exposure to shift work, including night shifts, are in line with the study by Lajoieet al. (11) that found an increase in MS risk in a population of HCWs who worked shift work >15 years. Contrary to this evidence, the role of cumulative lifetime exposure to shiftwork appears uncertain. In fact, in a recent study Korsiak et al. (10) found no significant association between MS and cumulative shiftwork in female hospital employees. In this study, although the risk of metabolic syndrome was elevated among women who worked ≥10 years, the CI was wide and crossed the null value of 1 after confounder adjustment. These findings have important limitations and indeed the authors of the study underlined that they did not use longitudinal data, and that it was possible that the study was underpowered, did not include enough variability in cumulative shift work exposure to detect differences, and that the comparator group included employees with other unmeasured personal or work characteristics that contributed to cardiometabolic risk.

The papers focused on the role of HCWs' individual determinants in the relationship between shiftwork and MS showed that poor sleep duration (10), sedentariness (20) and unhealthy eating habit (16) were positively associated to the risk of MS. In particular, Korsiak et al. (10) in a recent study found that shift workers slept less than day workers and were more likely to have MS, and concluded that poor sleep duration mediate the association between shiftwork and MS (OR=2.25, 95% CI 1.27 to 4.26). With regard to the quality of sleep, Lajoie et al. (11) in a cross sectional study found that shift-work was strongly associated with poor sleep efficiency with its components of prolonged sleep latency (difficulty falling asleep), waking during the night and early awakenings, and with poor overall sleep. Despite these evidences, the study of Lajoie et al. (11) found no association between poor sleep quality and MS in the studied shift-HCWs, hypothesizing other factors contributing to the relationship between shiftwork and MS, such as stress (sociotemporal disruption, poor work–life balance), unhealthy lifestyle factors (poor dietary habits, increased smoking and alcohol consumption and lack of physical activity) and other markers of circadian disruption (i.e., phase shifting of melatonin).

Risk management of MS

The two papers that focused on this topic discussed the implementation of primary or secondary prevention of MS through interventions based

Table 2 - Methods adopted to assess metabolic syndrome in the selected articles

Author and year	Methods to assess metabolic syndrome
Farha and Alefishat 2018 (5)	AHA/NHLBI: presence of at least three of the following conditions: FBG ≥100 mg/dL or on drug treatment for elevated glucose; blood pressure ≥130/85 mmHg or on antihypertensive drug treatment in a patient with a history of hypertension; TGs ≥150 mg/dL or on drug treatment for elevated TGs; HDL-C <40 mg/dL in men or <50 mg/dL in women or on drug treatment for reduced HDL-C; or waist circumference ≥102 cm in men or ≥ 88 cm in women.
Pietroiusti et al. 2010 (20)	NCEP: presence of at least three of the following conditions: waist >102 cm in men and >88 cm in women, serum triglycerides >1.695 mmol/l (150 mg/dl), HDL-cholesterol 1.036 mmol/l (40 mg/dl) in men and,1.295 mmol/l (50 mg/dl) in women, blood pressure >130 or >85 mmHg or treatment for hypertension, and plasma glucose >5.6 mmol/l (100 mg/dl)
Korsiak et al. 2017 (10)	2009 JISCS: presence of at least three of the following conditions: high waist circumference (≥80 cm); elevated triglycerides (≥1.7 mmol/L); reduced high-density lipoprotein (<1.3 mmol/L); elevated blood pressure (systolic ≥130 and/or diastolic ≥85 mm Hg); elevated fasting blood glucose (≥100 mg/dL).
Lajoie et al. 2015 (11)	According to the above mentioned "2009 JISCS"
Molzof et al. 2017 (16)	Fasting triglycerides and cholesterol (mg/dL), fasting blood glucose (mg/dL) and blood pressure measurements (mmHg), weight, height, and waist circumference
Copertaro et al. 2008 (4)	NCEP: presence of at least three of the following conditions: waist >102 cm in men and >88 cm in women, serum triglycerides >1.695 mmol/l (150 mg/dl), HDL-cholesterol 1.036 mmol/l (40 mg/dl) in men and,1.295 mmol/l (50 mg/dl) in women, blood pressure >130 or >85 mmHg or treatment for hypertension, and plasma glucose >5.6 mmol/l (100 mg/dl) - IDF: Central obesity plus any two of the following four factors: Raised triglycerides [≥ 150 mg/dL (1.7 mmol/L)] or specific treatment for this lipid abnormality; Reduced HDL cholesterol (< 40 mg/dL (1.03 mmol/L) in males < 50 mg/dL (1.29 mmol/L) in females) or specific treatment for this lipid abnormality; Raised blood pressure systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg or treatment of previously diagnosed hypertension, Raised fasting plasma glucose, (FPG) ≥ 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes.

on minimizing the impact of shift work on workers' health.

Based on the documented evidence of the association between sleep duration and MS in shift-HCWs, Korsiac et al. (10) recommended healthy workplace policies focused on increasing sleep duration among shift workers in order to mitigate the negative cardiometabolic effects of shift work. Moreover, Pietroiusti et al. (20) highlighted the need for appropriate medical surveillance of shift HCWs and, if necessary, work schedule changes for HCWs who develop MS.

Occurrence of MS

Among the six studies that investigated MS occurrence rates, four were cross-sectional studies (4, 5, 10, 11) and one (20) was a longitudinal study. The cross-sectional studies revealed that between 15.9% and 40.6% of shift-HCWs were affected by MS. This large range of occurrence rates was due to the different ways in which MS was assessed. In fact, a cross sectional study by Copertaro et al. (4) found significant differences in MS occurrence in the same population depending on the adopted method used

to assess MS. In particular, MS was more prevalent among shift workers than among daytime workers when using the International Diabetes Federation (IDF) (2), but not the Adult Treatment Panel III (ATPIII), definition (17). Based on this finding, the author concluded that the IDF was the method of choice to diagnose MS as it enabled early prevention of the heightened risk of cardiovascular disease associated with shift work. The assessment of the variable "years of shift work" was revealed to be a confounding factor that needed to be evaluated to stratify the occurrence of MS. In fact, a cross-sectional study Korsiak et al. (10) found that 20% of the studied population was affected by MS, but after adjusting for years of shift work the prevalence of MS was 25% among HCWs with >10 years of shift work and 10% among those with <10 years of shift work. The crude OR demonstrated an almost three-fold higher risk (OR=2.97, 95% CI 1.55 to 5.69), therefore suggesting an association between cumulative shift work and MS (OR=1.60, 95% CI 0.69 to 3.74). Pietroiusti et al. (20), in their longitudinal study, found that the cumulative incidence of MS during a 4-year follow-up was 9.0% among night-shift workers and 1.8% among daytime workers (RR 5.0, 95% C.I. 2.1 to 14.6). When adjusting for the different length of follow-up until event occurrence, the person-year method estimated that the annual rate of MS incidence was 0.5% in daytime workers and 2.9% in night-shift workers (log-rank test; p=0.001).

Conclusions

The findings of the present review highlighted that although MS is a major concern for shift-HCWs working in 24-hours hospital wards, to date a lack of evidence exists regarding the management of MS risk in shift-HCWs. Based on our findings, the main organizational determinants that should be evaluated in the risk assessment of MS are cumulative shift work including night shifts and number of nights worked per month per worker. In particular, with regard to the role of cumulative lifetime exposure to shiftwork, the findings of our review suggest a dose-response relationship between increasing years of shift work history and MS, in line with a meta-analysis performed by Wang et al. (25) among non-HCWs that reported that 10 or more years of shift work increased the risk of metabolic syndrome by 77%. Consistent with these findings, a study conducted in China (7) with a total of 9088 non-HCW shift workers showed that long-term shift work was associated with MS. In female workers, every 10-year increase in shift work was associated with a 10% (95 % CI: 1% -20%) higher odds of MS. Moreover, shift work duration was significantly associated with higher blood pressure levels, higher waist circumference, and increased glucose levels, which are all components of MS.

With regard to individual worker factors linked with MS in shift-HCWs, we found that, contrarily to the evidence in the literature that indicates the need to assess sleep deprivation as an independent risk factor for MS (6, 18, 25), only one study evaluated sleep duration in the assessment of MS risk in shift-HCWs, and demonstrated that poor sleep is a mediator for MS (OR=2.25, 95% CI 1.27 to 4.26). This finding is consistent with the study of Katano et al. (9) that examined the association between sleep duration and metabolic syndrome in shift workers and non-HCWs and revealed that a short sleep duration was positively associated with the risk of impaired glucose tolerance, dyslipidemia, and high blood pressure, independent of other lifestyle habits. Other studies point in the same direction and suggest that sleep deprivation can raise blood pressure, activate systemic inflammatory processes, and is an independent risk factor for diabetes (14, 22). In addition, sleep deprivation may be associated with glucose intolerance and insulin resistance (24). According to this evidence, we suggest the need to better investigate the role of sleep deprivation in the assessment of MS in shift-HCWs and clarify the role of such variables as confounders, mediators, or effect modifiers. Moreover, to date the data regarding management interventions focused on the risk of MS among shift-HCWs are inconsistent and therefore a special effort is required to detect strategic ways to minimize the likelihood of MS occurrence in shift-HCWs.

Limitations

This study has some limitations. The limited number of manuscripts included in this study does

not make it possible to draw strong conclusions. The manuscripts included in this study suffer from differences in the criteria adopted for the assessment of metabolic syndrome and for the analysis of confounders. Five of the six included studies were cross-sectional and, consequently, the nature of these studies limited the assessment of temporality and were therefore unable to establish a causal relationship between shift work and metabolic syndrome.

No potential conflict of interest relevant to this article was reported by the authors

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