CLINICAL REVIEW

Metabolic syndrome and shift work: A systematic review

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SUMMARY

The aim of this systematic review was to examine the association between shift work and metabolic syndrome (MetS) as well as the potential confounders investigated. A systematic search was conducted with the aim of finding original articles on the association between shift work and MetS. The included articles were chosen based on established inclusion criteria; their methodological quality was assessed using a validated quality checklist. A total of 10 articles were included in this review. The majority of the studies were classified as having a low risk of bias. The definitions of MetS and shift work varied between studies. Among the ten studies, eight found a positive association between shift work and MetS after controlling for socio-demographic and behavioral factors. Only three studies included sleep duration as a confounder, and these studies presented discordant results. We conclude that there was insufficient evidence regarding the association between shift work and prevalent MetS when the confounders are taken into account.

Introduction

Metabolic syndrome (MetS) represents a cluster of several interrelated risk factors of metabolic origin that are associated with all-cause mortality.[1] Although the most well-known proposed criteria for defining MetS have some differences in the inclusion and cutoff points of components, they all include glucose intolerance, hypertension, dyslipidemia and central obesity.[2–4]

Shift work is increasing in modern society as an important mechanism for greater flexibility in the organization of work schedules. This term refers to a work schedule that involves irregular or unusual hours, such as night work and rotating shift work, in contrast to normal daytime work.[5] Shift work is accompanied by a greater incidence of several health disorders, such as cardiovascular, metabolic, gastro-intestinal and mental disorders.[6–8]

Although research on the association between shift work and MetS has begun only recently, there are studies that suggest a higher prevalence of MetS and its components among shift workers when compared with day workers, particularly with regard to lipid and glucose intolerance.[9–11] It is noteworthy that the investigations of these studies have not reached a consensus about the potential confounders, i.e., variables that are associated with shift work and with MetS but that are not intermediate steps in the causal pathway.

A recent review on shift work and body weight change concluded that there is insufficient evidence for the association when confounders are taken into account, although there is strong evidence for the association in the crude analysis.[12] Additionally, another review on shift work and chronic disease suggested the need for further studies to tease out the lifestyle factors that may be mediators or potential confounders of the association.[13]

Finally, no systematic review has yet investigated the association between shift work and MetS. Thus, the aim of this systematic review was to examine the association between shift work and MetS as well as the potential confounders involved.

Methods

A systematic search was conducted with the aim of finding original articles on the association between shift work and MetS. The following databases were used: PubMed, Embase, Web of Science and Science Direct. We included articles published up to December 2011. The terms used in the searches were: metabolic syndrome X, metabolic syndrome, insulin resistance syndrome,

Glossary of terms

Metabolic syndrome: a combination of metabolic disorders that include central obesity, raised plasma glucose, triglycerides, increased blood pressure and reduced HDL cholesterol.
Night shift work: a working time that is extended through all or part of the night, and the number of nights worked per wk/mo/y can vary considerably.
Rotating shift work: a work schedule with hours that change at prescribed intervals.
Shift work: a method of organization defined by working time in which workers succeed one another at the workplace so that the establishment can operate longer than the hours of work with an individual set of workers.

shift work, night work, sleep disorders, circadian rhythm, work schedule tolerance and other terms related to observational studies. The search strategy used in PubMed is shown in Table 1. Additional papers were identified in the reference lists of selected articles that met the inclusion criteria. The searches were conducted by two independent reviewers, and their results were compared.

The articles retrieved from the literature met the following inclusion criteria: 1) the study design was observational; 2) the article was written in English, Spanish or Portuguese; 3) the article was original research; 4) the full text article was available; 5) the measured outcome included metabolic syndrome; 6) the study compared a group of shift workers (night shift workers or rotating shift workers) with a control group of day workers.

The two reviewers independently read all of the abstracts. The articles were included if they met all six inclusion criteria. If consensus between the two reviewers could not be reached, a third reviewer was called upon to make a final decision.

The data were extracted and tabulated using a table containing the following variables; first author, title of the study, date of publication, sample size, study design, non-response rate, follow-up duration, controlled confounders, exposure, metabolic syndrome criteria, crude results for metabolic syndrome and adjusted results for metabolic syndrome and for each component.

Recent guidelines for systematic reviews[14] have called attention to the importance of evaluating the quality of the studies' methodology, especially regarding possible bias. In this study, a validated

Table 1
Search strategy for PubMed.

Metabolic syndrome	Metabolic syndrome X [MeSH] OR metabolic syndrome [All Fields] OR insulin resistance syndrome [All Fields]
Shift work	Shift work [All Fields] OR night work [All Fields] OR sleep disorders, circadian rhythm [MeSH] OR work schedule tolerance [MeSH]
Study type	Case-control study [All Fields] OR case control study [All Fields] OR epidemiological studies [All Fields] OR retrospective studies [All Fields] OR cohort study [All Fields] OR incidence study [All Fields] OR cross-sectional study [All Fields] OR cross sectional study [All Fields] OR prevalence study [All Fields] OR longitudinal study [All Fields] OR follow-up study [All Fields] OR prospective study [All Fields] OR ecological study [All Fields].
Limits	English OR Spanish OR Portuguese AND adult

checklist originally proposed by Downs and Black[15] was used to assess the quality of the selected articles. This checklist, originally proposed to judge the quality of clinical trials, consists of 27 questions that evaluate five domains: reporting, external validity, internal validity, confounding and power. Subsequently, Monteiro and Victora adapted this checklist for observational studies[16]; from the original checklist, questions 8, 13, 23, and 24 were eliminated for longitudinal studies, and questions 8, 9, 13, 17, 23 and 22 were excluded for the assessment of cross-sectional studies. The questions received scores of 0, 1 or unable to determine; an exception to this convention was for question 5, which could be scored from zero to 2. This adapted form was used in this study.

The two reviewers independently applied the checklist to assess the quality of the retrieved articles. The quality of the articles was first evaluated according to the established questions, which were scored using the following values: 1 if the item was contemplated in the study and 0 if the item was not or was not able to be determined. The number given by the total sum of the questions was then divided by the number of total applicable items in the study and finally multiplied by 100. Studies with a score greater than 51% were classified as having a "low risk of bias." Otherwise, the studies were classified as having a "risk of bias." In the second stage of the evaluation, a general assessment of the quality of the articles was performed in each domain of the evaluation instrument (reporting, external validity, internal validity, confounding and power) in the same way. Similarly, the domains that had a score greater than 51% were classified as having a "low risk of bias," whereas lower scores reflected a "risk of bias." When the determination of most of the information was unclear, we considered the domain as having an "unclear risk of bias."

Results

The results of the selection procedure are presented in Fig. 1. The search strategy resulted in 554 articles (405 from PubMed, 26 from Embase, 93 from Science Direct and 21 from Web of Science). After excluding duplications, 526 titles and abstracts were examined; nine full texts were selected for investigation. Six articles met all of the inclusion criteria. The references of these articles were checked, resulting in four additional articles. A total of 10 articles were included in this review. Three articles were excluded for the following reasons: for two articles, no MetS outcome measure was shown in any of the analyses[17,18]; in the third article, the study population was not healthy, which could have modified the final results.[19]

In Table 2, we show the population and design characteristics of the studies. The studies showed diverse population characteristics. The workers were included from various fields, such as large industries, healthcare systems and police stations. The majority of the studies had been conducted in European countries, followed by Asian countries. Four studies included only men, one included only women and five included both sexes. The sample sizes of the studies ranged between 98 and 27,485 workers, and the average age of the participants was between 30 and 47 y old. We retrieved three cohort studies (two prospective[20,21] and one retrospective[22]), six cross-sectional studies[6,9,11,23–25] and one case-control study.[26] The non-response rates in these studies ranged from 4% to 60%.

The individual quality assessment scores for the studies are also shown in Table 2. Among the ten selected papers, only two studies received scores of quality below 51%,[9,20] which demonstrates the high quality of the studies included in this review. Karlsson's study received a score of less than 51% because it had been performed before the scientific literature provided rather consistent definitions for shift work and MetS. Nevertheless, it was the first study to address the issue of shift work and MetS.[9]