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FATORES ASSOCIADOS AOS DISTÚRBIOS METABÓLICOS EM TRABALHADORES DE TURNOS DE UM FRIGORÍFICO DO SUL DO BRASIL

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“A verdadeira viagem do conhecimento não consiste em procurar novas paisagens, mas em ter novos olhos.”

Marcel Proust

Eu dedico este trabalho à minha amada família:

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SUMÁRIO

RESUMO

O trabalho em turnos tem crescido na sociedade moderna como um mecanismo importante para uma maior flexibilidade na organização dos horários de trabalho. Este termo refere-se a um horário de trabalho que envolve horários irregulares ou incomuns, como o trabalho noturno e por turnos rotativos, em contraste com trabalho diurno normal. Porém o trabalho em turnos é acompanhado por uma maior incidência de diversos problemas de saúde, tais como doenças cardiovasculares e metabólicas. Assim, o objetivo deste trabalho foi investigar os fatores associados à obesidade e à síndrome metabólica em trabalhadores de turnos de um frigorífico de frango do Sul do Brasil. Para tanto, foi conduzido um artigo de revisão da literatura e dois artigos originais.

O artigo de revisão sistemática da literatura investigou a associação entre trabalho em turnos e síndrome metabólica. Os artigos incluídos foram escolhidos com base em critérios de inclusão estabelecidos; sua qualidade metodológica foi avaliada utilizando uma lista de verificação de qualidade validada, sendo que a maioria dos estudos foi classificada como tendo um baixo risco de viés. Entre os 10 estudos recuperados, oito encontraram uma associação positiva entre o trabalho por turnos e síndrome metabólica após o controle de fatores sócio-demográficos e comportamentais. Mas apenas três estudos incluíram duração do sono como um fator de confusão, e esses estudos apresentaram resultados discordantes. Assim, conclui-se que não existem provas suficientes sobre a associação entre trabalho por turnos e síndrome metabólica, especialmente quando os fatores de confusão são levados em conta.

Os dois artigos originais foram elaborados através de um estudo transversal com uma amostra de 905 trabalhadores de ambos os sexos de um frigorifico, que funciona nas 24 horas do dia, no Sul do Brasil. O primeiro artigo teve por objetivo investigar a relação entre privação de sono e obesidade geral entre os trabalhadores, controlando na análise multivariável para possíveis fatores de confusão. A obesidade definida como índice de massa corporal 30 kg/m^2 e a privação do sono definida através do número de horas de sono e eventuais cochilos. Como principais achados pode-se destacar que os

diferentes níveis de privação de sono mostraram-se relacionadas à maior renda, ao número de refeições realizadas durante o dia e ao trabalho noturno. Após ajustes na análise multivariável, trabalhadores que reportaram privação severa de sono (dormiam ≤5 horas por noite e não realizavam cochilos) tiveram uma probabilidade 4,57 vezes maior de apresentar obesidade. Assim, nossos achados demonstram uma forte associação entre privação de sono e obesidade em trabalhadores de turnos. Além disso, evidencia que a privação do sono poder ser uma consequência direta do regime de trabalho noturno.

O segundo artigo original investigou a prevalência de síndrome metabólica (SM) e a sua associação com fatores demográficos, socioeconômicos e comportamentais nos trabalhadores. O diagnóstico da SM foi realizado de acordo com as recomendações do "*Harmonizing the Metabolic Syndrome".* A distribuição de cada um dos componentes da SM foi avaliada de acordo com as características demográficas, socioeconômicas e comportamentais da amostra. A análise multivariável seguiu um modelo teórico de determinação da SM em trabalhadores de turnos. Dessa forma, a prevalência de SM mostrou-se positivamente associada às mulheres, trabalhadores com mais de 40 anos e que relataram dormir cinco ou menos horas por dia. Por outro lado, a SM mostrou-se negativamente associada ao maior nível de instrução e a realizar mais do que três refeições por dia. Já sexo, idade e escolaridade mostraram-se relacionados à maioria dos componentes da SM alterados. Entretanto, as variáveis comportamentais mostraram-se associadas apenas à CC e PA alteradas. Em suma, sexo, idade, escolaridade, hábitos alimentares e duração do sono mostraram-se como fatores de risco independentes para a ocorrência da SM em trabalhadores de turnos.

Palavras chave: Síndrome Metabólica; Obesidade; Trabalho em turnos, Privação do sono

ABSTRACT

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. Shift work is accompanied by a greater incidence of several health disorders, such as cardiovascular and metabolic disorders. The aim of this study was to examine the factors associated with obesity and metabolic syndrome in shift workers among a poultry processing plant in southern Brazil. For this, we conducted a systemic review of the literature and two original articles.

The aim of this systematic review was to examine the association between shift work and Metabolic Syndrome. 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. 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.

The two original articles were developed by a cross-sectional study was conducted on a sample of 902 shift workers of both sexes in a poultry processing plant in Southern Brazil that functions 24 hours per day. The objective of first manuscript was to explore the association between sleep deprivation and obesity among shift workers, controlling for possible confounders. Obesity was defined as body mass index ≥ 30 kg/m^2. Sleep deprivation were associated with increased income, number of meals consumed throughout the day and nightshift work. After controlling, the prevalence ratios of obesity were 4,57 in the workers with sleep deprivation compared to the reference group. These results show a strong association between sleep deprivation and obesity in shift workers, and that sleep deprivation may be a direct consequence of working at night.

*The second original manuscript investigated the prevalence of metabolic syndrome (MS) and its association with demographic, socioeconomic and behavioral factors in shift workers. The diagnosis of SM was determined according to the recommendations from "Harmonizing the Metabolic Syndrome". The distribution of each of the components of MS was evaluated according to the demographic, socioeconomic and behavioral characteristics of the sample. The m*ultivariate analysis followed a theoretical framework for determining MS on shift workers. *The prevalence of MS was positively associated with women, workers of over 40 years of age and those who reported sleeping five or less hours per day. On the other hand, MS was negatively correlated with higher educational level and having more than three meals per day. In conclusion, sex, age, educational level, eating habits and duration of sleep appeared as independent risk factors for MS.*

Keywords: *Metabolic syndrome; Obesity; Shift work; Sleep deprivation*

INTRODUÇÃO

Hoje em dia, as grandes indústrias, influenciadas pela globalização econômica e as rápidas mudanças nos processos tecnológicos, funcionam muito além dos horários diurnos e dos chamados dias úteis. Seus funcionários são distribuídos em turnos de trabalho, que se estendem durante as 24 horas do dia, todos os dias. Embora cada empresa tenha sua forma de organizar os horários e rotinas de trabalho, atualmente, define-se trabalho por turnos (*shift work*) como aquele realizado fora dos horários habituais (entrada 8 ou 9 horas; saída 17 ou 18 horas) ou, ainda, o trabalho de forma contínua durante 24 horas através do revezamento de equipes.[1]

Foi esta nova realidade, a partir da década de 70, fez com que pesquisadores da área da saúde ocupacional começassem a estudar o trabalho em turnos como agente etiológico ou fator de risco de natureza ocupacional no trabalho. Desde então, vários estudos têm investigado os efeitos do trabalho por turnos à saúde dos indivíduos e coletividades, em todo mundo. Publicações da última década sugerem uma relação entre alteração dos padrões de sono-vigília, estilo de vida e doenças crônicas não transmissíveis, como obesidade geral, obesidade abdominal e distúrbios metabólicos.[2-7]

O mecanismo que torna os trabalhadores de turnos um grupo de risco para os distúrbios metabólicos ainda é controverso. Mas, sabe-se que o ritmo circadiano está envolvido na regulação de inúmeras funções ligadas ao mecanismo da fome/saciedade, digestão e metabolismo dos alimentos. Além disso, determinados comportamentos de risco relacionados às escalas de trabalho, como consumo alimentar irregular, falta de rotina de sono, tabagismo, consumo excessivo de bebidas alcoólicas e bebidas estimulantes podem agravar ainda mais os prejuízos à saúde causados por essa rotina de vida.[8]

Dessa forma, o objetivo deste trabalho foi investigar os fatores associados à obesidade e à síndrome metabólica em trabalhadores de turnos de um frigorífico de frango do Sul do Brasil.

APRESENTAÇÃO

Esta tese de doutorado segue o formato proposto pelo Programa de Pós-Graduação em Ciências Médicas: Endocrinologia da UFRGS, sendo apresentada na forma de três manuscritos referentes a temática proposta pela tese. Cada artigo está formatado de acordo com as regras da revista ao qual foi ou será submetido.

1. Artigo de revisão: Síndrome Metabólica e Trabalho em Turnos: uma Revisão Sistemática (aceito pela revista *Sleep Medicine Reviews*)

2. Artigo original 1: Privação de Sono e Obesidade em Trabalhadores de Turno de um Frigorífico do Sul do Brasil (será submetido à *International Journal of Obesity*)

3. Artigo original 2: Fatores Associados à Síndrome Metabólica em Trabalhadores de Turnos (será submetido aos Cadernos de Saúde Coletiva)

PARTE I

Artigo de Revisão:

METABOLIC SYNDROME AND SHIFT WORK: A SYSTEMATIC 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.

Keywords: Metabolic syndrome, Shift work, Systematic review, Sleep disorders

Abbreviations:

HDL cholesterol: High-density lipoprotein cholesterol; IDF: International; Diabetes Federation; MetS: Metabolic Syndrome; NCEP ATP: National Cholesterol Education Program’s Adult Treatment Panel; HR: hazard ratio; SES: socioeconomic status

Glossary of terms:

Metabolic Syndrome: a combination of metabolic disorders that include central obesity, rapidly raised plasma glucose, triglycerides, 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 week/month/year 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.

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, 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 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 & 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 0 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 Figure 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 ten 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 years 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 consistency definitions for shift work and MetS. Nevertheless, it was the first study to address the issue of shift work and MetS.[9]

The assessment of the quality of the study methodology for the five domains (reporting, external validity, internal validity, confounding and power) is shown in Figure 2. More than 75% of the studies had a low risk of bias in item reporting. The assessment of external validity showed that most of the articles were not clear about how their participants were selected. The majority of the studies were classified as having a “risk of bias” in the internal validity domain. All of the studies were classified as having a “low risk of bias” in the confounding domain. None of the studies reported a power calculation for their sample size.

The results from the studies included in this review are summarized in supplementary Table (S1). The criteria for MetS varied between the studies. However, the most frequently used criteria were the recommendations from the National Cholesterol Education Program’s Adult Treatment Panel III (NCEP-ATPIII). Two studies compared the criteria from the NCEP with those of the International Diabetes Federation (IDF)[6,23], while two other studies did not use any definition and replaced waist circumference with body mass index.[9, 22]

We also found that different shift work classifications were used for each study. The authors of the studies used different methods for data collection and different definitions for shift work and its schedule (rotations compared with night and day work); in addition, some studies did not specify how the work variables were collected and classified.[9, 22] Two studies compared night workers with day workers.[11, 21] Six studies compared rotating shift workers with daytime workers.[6, 20, 22-25] Two other studies had shift work as an exposure variable but did not explain how this variable was collected.[9, 26]

Eight of the ten studies showed a statistically significant association between shift work and MetS in a crude analysis[6, 11, 20-25] (Tab S1). Among the studies that considered night shift work as the exposure rather than rotating shift work, one study found a five-fold increased risk of MetS in night-shift workers [21], while the other study found no significant association.[11] Among the six studies that included rotating shift workers, five studies found a positive association between MetS and rotating shift work[6, 20, 22, 23, 25], while one study found a negative association between rotating shift work (specifically, a 2-rotation shift system) and MetS.[24]

We show the variables that were entered in the multivariable analysis. Only one study was not included in the multivariable analyses.[6] In all the studies, the potential confounders considered included demographic variables, such as sex and age; some of the studies included additional potential confounder such as education[11, 20], marital status[11] and socioeconomic situation[9] as well as behavioral variables, such as smoking [11, 20-22, 24-26], physical activity[11, 20-22, 24-26], and alcohol consumption.[11,21-26] Three studies investigated the relationship of sleep[11,24,26] or diet [22,23,26] as potential confounders on the association between shift work and MetS (Tab S1).

Among the studies that had night shift work as the exposure, a positive association between shift work and MetS was found after adjusting for the confounders. In the Pietroiusti study, the association remained after controlling for demographic and behavioral variables.[21] In the Violanti study, the mean number of MetS components remained non-significantly different between night workers and day workers after adjusting for demographic and behavioral variables. However, upon stratification by sleep duration, the study found that among workers reporting less than 6 hours of sleep per night, the mean number of MetS components was significantly higher for those workers who worked midnight shifts compared with those who worked day shifts.[11]

Except for the one study that did not have a multivariable analysis[6], the studies that examined rotating shift workers found that the association between the exposure and outcome was maintained after adjustment for potential confounders. In these studies, the variables entered in the multivariable models as potential confounders included age, education, marital status, smoking, alcohol consumption, physical activity, diet behaviors and family history. Only one study included sleep duration as a potential confounder and found an inverse association between rotating shift work and MetS after adjusting for this variable.[24]

The two authors who did not explain their shift work classification (night shift or rotating shift) showed that shift work exposure was associated with an increased risk of developing MetS after adjusting for sex, age, socioeconomic situation [9], smoking, alcohol consumption, physical activity, work intensity, sleep duration and eating habits.[26]

DISCUSSION

This is the first systematic review that focused on the association between shift work and MetS, and we concluded that there was no sufficient evidence for an association between shift work exposure and MetS occurrence when confounders were taken into account.

While longitudinal studies are well known for being a better study design to investigate the direction of association, most of the studies selected for this review had a cross-sectional design. Most of the studies were considered to be of high quality, i.e., they were rated as having a “low risk of bias” in most domains. However, major problems were found in the power and external validity domains, mostly because the authors did not describe their sample size calculations and did not rely on representative samples, respectively.

Our results should be interpreted in light of certain limitations. The definition of MetS varied between studies, thereby limiting the comparability among the studies. The majority of the studies used the ATP III 2005 or IDF criteria. Two studies also used, in addition to the diagnosis of MetS by the ATP III criteria, the IDF criteria. Two studies did not use any criteria in their definitions, and they replaced waist circumference with body mass index, resulting in a misclassification in the diagnosis of MetS.

Another limitation of these studies, which increased the difficulty of comparing them, was the different methods used for data collection and the different definitions used for shift work and schedules. Of course, each company has its own way of organizing its work schedules and routines, which makes comparisons among different studies complicated. Nonetheless, the usual definition of shift work is a schedule involving irregular or unusual hours, including night work and rotating shift work, which are in contrast to a standard work schedule, i.e., beginning at approximately 8 am and ending at approximately 5 pm over 5 days a week.[27] However, in this review, some studies did not follow this criterion, increasing the risk of misclassification in the assessment of the work schedule.

Our review retrieved only two studies that compared night workers with day workers. Pietroiusti et al. reported that working night shifts was associated with an increased risk of metabolic syndrome; their classification of night shift was a work schedule with an average of 4 nights per month, while day shift was classified as work between 7 am and 9 pm.[21] Likewise, the other study authored by Violanti et al. found a statistically significant association between night work (starting at 8 pm and ending at 3:59 am) and MetS when compared with day work (starting at 4 am and ending at 11:59 pm).[11]

Among the six studies that compared rotating shift workers with daytime workers, five studies found a positive association between rotating shift work (2- or 3-shift systems) and MetS.[6, 20, 22, 23, 25] Two other studies had shift work as an exposure variable but did not explain how this variable was collected.[9, 26]

Shift work is a term that refers to a wide variety of work-hour arrangements involving two or more teams (shifts) that differ in their starting and finishing work times.[8] The physiological adaptation to night work might be different from the adaptation to rotating shift work. We did not find studies that examined metabolic disorders in shift workers with a focus on comparing the different systems of shift work. Nevertheless, some reviews that addressed the impact of the different work systems in sleep-wake disturbances and safety concluded that rotating shifts may carry a higher safety risk than regular night shifts.[28] Therefore, according to the level of research evidence achieved, combinations of individual shift characteristics should be avoided in any one study.[8] Even after a prolonged period of night-shift activity, only a minority of night workers seemed to readapt their circadian system to the nocturnal activity.[29]

Additionally, different shift work systems have potentially different consequences for workers' health, including disturbances in their circadian rhythm, an essential biological function, and inducing sleep deprivation.[30] In addition to work schedules, other factors can affect tolerance to shift work and its consequences for workers' health, such as individual characteristics, economic conditions, lifestyle (food intake habits, physical activity, smoking and alcohol intake), working conditions and the occurrence of MetS, which is the studied outcome in this review.

Our review described the role of demographic, socioeconomic and behavioral variables as confounders in the association between shift work and MetS, i.e., whether those variables introduced a distortion in the association. A confounding variable is an extraneous variable in a statistical model that correlates (positively or negatively) with both the exposure and the outcome variable.[31] Most studies included demographic variables such as age and sex in their multivariable models or used these variables for stratified analyses. These methods were due to the already established associations between age and sex and the occurrence of MetS; generally, women have a higher prevalence of MetS than men, and the frequency of MetS increases in both sexes with advancing age.[32, 33] Although not yet definitively shown, older workers may be at a higher risk of injuries in night shift work.[34]

Even without a consensus on the direction of the association, socioeconomic status (SES) also influences the prevalence of MetS. Some studies have reported an inverse association between SES (determined by income and education level) and MetS.[35, 36] Meanwhile, Park et al. examined a Korean population and found that the association between SES and the prevalence of MetS differs by sex, with a positive association for men and an inverse association for women.[37] Another important consideration is that day workers often do other types of work than shift workers, including maintenance and repairs, and they may also differ from shift workers with respect to socioeconomics. One study in this review included socioeconomic variables in its multivariable analysis.[9]

Behavioral characteristics, such as smoking, drinking alcohol and food intake habits, have been considered as potential confounders in many studies. Shift work has been described as a risk factor for smoking behavior .[17] Several studies have also shown that smoking is associated with metabolic abnormalities and increases the risk of MetS.[38, 39] As previously shown, smoking induces insulin resistance[40], elevates plasma triglycerides[41] and reduces high-density-lipoprotein cholesterol.[42] In a review, Lin et al. indicated smoking and night work as risk factors for MetS. [22]

Another risk factor associated with shift work and MetS is alcohol intake, although the overlap of alcohol consumption with different components of MetS makes the alcohol–metabolic syndrome association a controversial topic. Alkerwi et al. found in a recent meta-analysis study that consuming less than 40 g alcohol/day in men and 20 g alcohol/day in women significantly reduced the prevalence of MetS. The authors concluded that "responsible alcohol intake" may be associated with a reduced prevalence of MetS; however, this study was not conducted among shift workers.[43]

Shift workers also have irregular eating habits because of the temporal reorganization of food consumption. Most studies have found no association between total energy intake and macronutrient fractions. Among shift workers, studies have found a redistribution of food consumption, i.e., these workers eat a larger number of smaller meals throughout the day compared with those individuals working day shifts[23, 44-46]; Lennernas et al. described this reorganization to result in a higher consumption of food among night shift workers.[47] Higher consumption of food during the night may contribute to a desynchronization of the rhythmicity of glucose and triglycerides; consequently, abdominal fat deposits and dyslipidemias increase.[48, 49] These findings may explain the interaction between MetS and the dietary patterns of night workers.

The benefits of physical activity in the control and reduction of overweight status and metabolic disorders have been well described in the literature.[50] However, another mediator may act after physical activity in the association between shift work and MetS. The practice of regular physical activity can help synchronize the circadian rhythms through stabilizing the individual's behavioral habits, which may help in the prevention as well as the treatment of problems arising from the exposure to shift work.[51]

In summary, smoking, alcohol consumption, food intake habits and physical activity are behaviors that have been found to be associated with the occurrence of MetS and are strongly influenced by work schedule. Generally considered as confounders in epidemiological studies, they may also be intermediate factors in the effects of shift work on metabolic syndrome.

Lastly, the reduction of sleep duration per se may not be a benign phenomenon and can exert important metabolic effects. A recent systematic review of both cross-sectional and longitudinal studies revealed that short sleep duration is independently associated with weight gain, particularly in younger age groups.[52] In addition to visceral obesity, other components of metabolic syndrome can be affected by sleep duration. Katano et al. examined the r association between sleep duration and metabolic syndrome and revealed that short sleep duration was positively associated with the risk of impaired glucose tolerance, dyslipidemia and high blood pressure, independent of other lifestyle habits.[53] Other studies point in the same direction: sleep deprivation can raise blood pressure[54, 55], activate systemic inflammatory processes[56, 57] and is an independent risk factor for diabetes.[7, 58] In addition, sleep curtailment may be associated with glucose intolerance and insulin resistance.[59]

Such evidence suggests that sleep deprivation is an independent risk factor for MetS. However, in our review, only three articles considered the duration of sleep as a confounder in their analyses, and these studies presented discordant results: one study found a negative association between the presence of MetS and two-rotation shift work when compared with day work[24]; and the other two studies found a positive association between night shift work and MetS when adjusted or stratified for sleep duration.[11, 26] Moreover, in Violanti's study, a test for interaction was used to determine if total hours of sleep modified the association between shift work and metabolic syndrome; this interaction was not found to be statistically significant.[11] Nevertheless, no study has considered sleep duration as a possible mediating factor, i.e., as a variable that occurs in the causal pathway between shift work and MetS.

CONCLUSION

The purpose of this systematic review was to retrieve original articles that examined the influence of shift work on the occurrence of MetS and to raise some methodological problems presented in these studies.

Methodological problems were found in these investigations. Some studies used arbitrary classifications of MetS. For example, misclassification could have occurred when waist circumference was replaced by body mass index. Similarly, different definitions were used to identify shift work: some studies did not take into consideration the theoretical conceptual definitions of shift work, night shift work or rotating shift work; in a few other studies, the collection and classification of this variable were not described. The different criteria used to classify both MetS and shift work as well as the misclassification errors of these same concepts make it difficult to compare the studies.

Another methodological issue that is very important in this type of epidemiological investigation is the main confounders included in the multivariable analyses. Sociodemographic confounders (age and sex) were included in all of the studies; most of the studies that used a multivariable analysis also included smoking, physical activity and alcohol consumption. However, few studies adjusted for other important confounders such as education, marital status, socioeconomic status and diet. In the scientific literature, all of these variables have been found to be of particular importance in the association that links shift work with MetS. Thus, these confounders are expected to be present in the theoretical models of the studies investigating this association.

Moreover, the literature has documented a strong association of sleep duration to shift work and metabolic disturbances, but the role of sleep in these pathways, that is, as a confounder, mediator or effect modifier, is still unclear. Thus, sleep duration should receive special attention because it is often overlooked in studies investigating the influence of shift work on health.

We conclude that there was insufficient evidence regarding the association between shift work and prevalent MetS when the confounders are taken into account. Additional research, consisting of adequately powered cohort studies or interventional clinical trials are needed to examine whether shift work may indeed increase the predisposition for MetS"

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Practice Points:

1- In the literature reviewed, there was not sufficient evidence to determine the association between shift work and metabolic syndrome;
2- The different criteria used to classify both metabolic syndrome and shift work as well as the misclassification errors of these same concepts make it difficult to compare studies;
3- Socioeconomic determinants, such as education, marital status and socioeconomic status, were not considered as potential confounders in most studies;
4- The literature has documented a strong association of sleep duration to shift work and metabolic disturbances, but the role of sleep deprivation in these associations, i.e., as a confounder, mediator or effect modifier, is still unclear.

Research Agenda:

More research is needed to investigate the association between shift work and metabolic syndrome. Such research may consider:

1- Studies with representative samples of workers and those that describe their sample size calculations are necessary for the assessment of the power and external validity;
2- The standard definition of shift work should be used to classify night work or rotating shift work and their schedules so that we can compare the results of shift work studies and decrease the likelihood of misclassification;
3- Potentially relevant confounders should be appropriately measured and considered in a multivariable model based on a conceptual framework determined a priori;
4- The role of sleep should be clarified in the association between shift work and metabolic disturbances, i.e., whether sleep duration would act as a confounder, mediator or effect modifier.

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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

Figure 1. The search and selection process in systematic review.

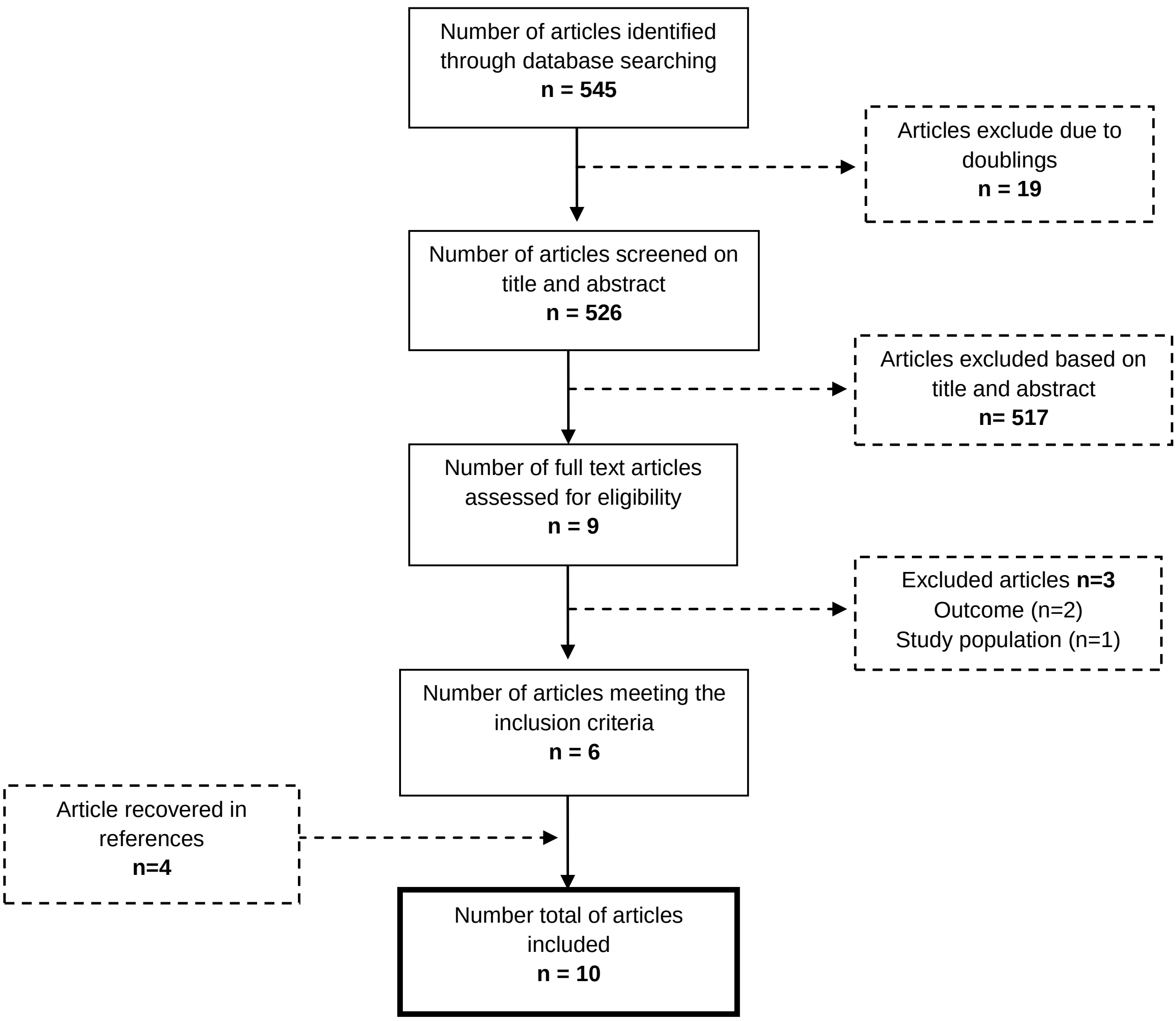

Figure 2. Resume of quality assessment of studies include in the review, according to the risk of bias in each domain assessed by instrument proposed by Downs & Black (n= 10 studies).

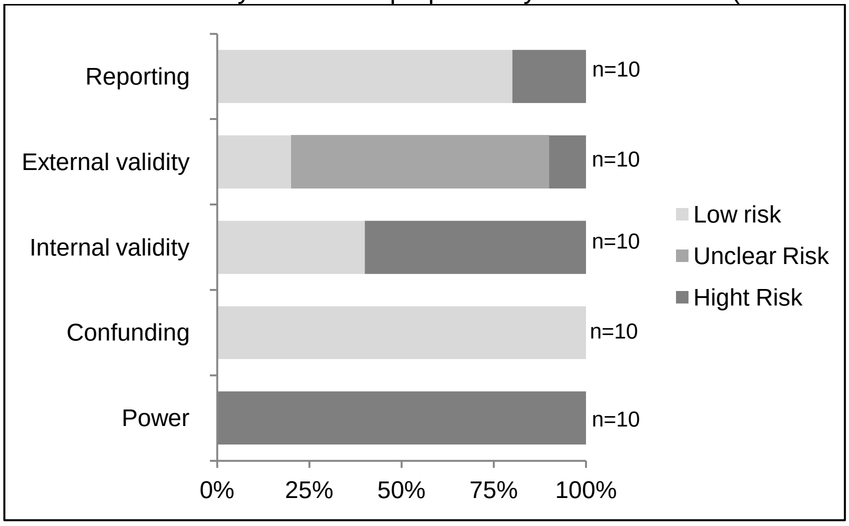

Table 1. Summary of study characteristics and methodological approaches (n=10).

Study	Year of data collection	Study population	Design	Sample size	Age (years) Mean (SD)	Follow-up	Non-response rate	Quality score
Pietroiusti et al, 2011[21]	2003 – 07	Italian male and female nurses.	Prospective	738	Shift workers 38.9 (8.4) Day workers 37.9 (8.5)	4 year	12.2%	75%
De Bacquer et al, 2009 [20]	1995/98 – 2002/03	Male workers several large companies in Belgium.	Prospective	1.529	47.9 (7.2)	6.6 years	31.5%	50%
Lin et al, 2009[22]	2002 – 07	Taiwanese female workers among electronic manufacturing company.	Retrospective	387	32.8 (7.9)	5 years	1%	70.8%
Violanti et al, 2009 [11]	1999/2000	Male and female police officers American.	Cross-sectional	98	39. 5 (7.6)	NA	14.8%	71.4%
Copertaro et al, 2008 [6]	2005	Healthcare workers (doctors, nurses and auxiliaries) from the Italian Health Service.	Cross-sectional	147	43.9	NA	2.3%	52.5%
Esquirol et al, 2009 [23]	2001/02	France male workers chemical plant.	Cross-sectional	198	47.7 0.3)	NA	10%	76.2%
Kawada et al, 2010[24]	2008	Japanese males employees of a car-manufacturing company.	Cross-sectional	3.007	44.9	NA	-	71.2%
Sookoian et al, 2007[25]	2005	Male subjects recruited from a factory in Buenos Aires.	Cross-sectional	1351	Shift workers 36(1) Day workers 34 (1)	NA	-	57.1%
Karlsson et al, 2001[9]	1992/97	Working population of people from the north of Sweden.	Cross-sectional	27.485	Age stratification	NA	60%	33.3%
Li et al, 2011[25].	1887/90	Japanese males and female workers.	Case-control	6.712	Half of all shift workers age 30–39	NA	-	62.3%

NA: not applicable ; SD: standard deviation

Tab S1. Summary of the main results of studies.

Study	MetS classification	Exposure classification	Variables entered in the multivariate analysis	MetS Crude Analysis	MetS Adjusted Analysis
NIGHT SHIFT WORK					
Violanti et al, 2009[11]	NCEP ATP III	**Day shift:** start times of 4am to 11:59am; 10h per day. **Afternoon shift:** start 19:59pm; 10h per day. **Midnight Shift**: start 9pm to 3:59am; 10h per day.	Sex, age, education, marital status, smoking, alcohol consumption, physical activity, police rank and sleep duration.	Officers working the midnight shift had the highest mean number of MetS components (1.70; SD 1.34) compared with officers working the day (0.97; SD 1.27) and afternoon (1.25; SD 1.37) shifts. These means were not statistically significant.	After stratification analysis by sleep duration the mean number of MetS components was higher in midnight-shift workers compared with day-shift workers: 2.56 vs. 0.59; p=0.013
Pietroiusti et al, 2011[21]	NCEP ATP III	**Day shift:** between 7am and 9pm **Night shifts:** working average of 4 nights per month.	Sex, age, smoking, alcohol consumption, leisure-time physical activity, familiar history for any component of the MetS or overt cardiovascular disease.	The cumulative incidence of MetS was 5.7% (RR= 5.0; $CI_{95\%}$ 2.1 to 14.6).	The rate of MetS was higher in night-shift workers: HR 5.10; $CI_{95\%}$ 2.15 to 12.11; p=0.001
ROTATING SHIFT WORK					
Copertaro et al, 2008[6]	NCEP ATPIII and IDF	**Day Shift:** no specification. **Rotating shifts:** **1) Doctors:** worked on average one and a half night shifts a month. **2) Nurses and auxiliaries**:did six nights a month (first day: 6 am to 2 pm; second day: 2 pm to 10 pm; third day: 10 pm to 6 am) followed by 48 h of rest and then resumption of the cycle.	No multivariate analysis.	In comparing shift and day workers, different prevalence of MetS were observed depending on the MetS criteria: **ATPIII:** 11,4% vs. 10,3%; NS **IDF:** 28,6% vs. 37,1%; p<0,05.	-
De Bacquer et al, 2009[20]	IDF adapted; WC ≥90cm more 2 components: BP ≥ 130/85 mmHg or HAS HDL <40 mg/dl TG ≥220 mg/dl FPG >=120 mg/dl or DM	**Day shifts:** no specification **Rotating shifts:**2- or 3-rotation shifts	Age, smoking, education, leisure-time physical activity, job strain, physical job demands and MetS components at baseline (WC, DBP, HDL).	The odds of MetS were higher among shift workers (OR: 1.77; $CI_{95\%}$ 1.34–2.32)	Adjusted odds ratio: 1.46 ($CI_{95\%}$ 1.04 to 2.07). Men over 45 years of age who worked for over 10 years in shifts had higher odds compared with daytime workers (OR: 1.82, $CI_{95\%}$ 1.23 to 2.69).
Esquirol et al, 2009[23]	NCEP ATPIII and IDF	**Day shifts:** start times of 8 am; 8 h per day, 5 days for week **Rotating shifts:** starting 5 am; 1 pm or 9 pm; 8 h per day	Age, smoking, alcohol consumption, total physical activity, carbohydrate intake, total energy intake and contributions to daily energy intake of meals from breakfast, morning, afternoon, and night light meals; work organization and job strain index	The prevalence of MetS, as defined by NCEP-ATPIII, was 16% and 22%, respectively, in day and shift workers (p= 0.07). However, no relation was observed using the IDF score.	Adjusted odds ratio: 2.33 ($CI_{95\%}$ 1.04 to 5.23)
Kawada et al,	Japanese criteria:	**Day shift**: work was 8am to 5pm	Age, smoking, alcohol consumption, exercise,	The prevalence of MetS in	There was a negative association between

2010[24]	With 2 or more of: WC>85 cm TG ≥150 mg/dl; HDL <40 mg/dl); BP≥85/ 130 mmHg FPG ≥110 mg/dl	**Two-rotation shift:** starting at 6:30am or 3pm **Three-rotation shift:** beginning at 6:30am, 2:30pm and 10:30pm.	sleep.	day workers, 2-rotation shift workers and 3-rotation shift workers were 13.8%, 10.7% and 17.6%, respectively. This difference was significant between the 2-rotation shift workers and the day workers.	the presence of MetS and two rotating shift work (ODS= 0.77 CI95% 0.61–0.98), when compared to day work. Three rotating shift work was not statistically significant.
Sookoian et al, 2007[25]	NCEP ATP III	**Day shift**: starting between 7pm and 8pm; working 8h per day. **Rotating shifts**: starting at 6am or 6pm; working 1 h per day	Age, smoking, alcohol consumption and physical activity.	The simultaneous presence of three or more metabolic risk factors was significantly more common in rotating shift workers (17.2%) in comparison with day workers (10.7%, $p < 0.005$).	The OR for MetS in rotating shift workers compared with day workers was 1 .51 ($CI_{95\%}$ 1.01 to 2.25, $p < 0.04$).
Lin et al, 2009[22]	NCEP/ATPIII (WC: female≥80;male≥90 cm)	**Persistent day shift:** no specification **Ever rotating shift:** started 7am or 7:30pm; working 6 day-shifts → 3 rest day-s → 6 night-shifts, etc.; **Persistent day-night rotating shift:** work in day and rotating shifts in the last 5 years.	Age, smoking, exercise, diet behaviors, baseline insulin resistance status, pre-MetS status and MetS components.	The prevalence of development of MetS within 5 years in different shifts work: persistent day workers (pDW) 5.6% vs. ever had day–night rotating shift workers (eRSW) 6.9% vs. persistent day-night rotating shift work (pRSW) 15.7% . Statistically significant differences (p≤0,05) were found between: pDW and pRSW; eRSW and pRSW.	After 5 years of work the risk of developing MetS was higher in pRSW subjects compared with those having a persistent day job (RR= 3.5, $CI_{95\%}$: 1.3 to 9.0)..
SHIFT WORK					
Karlsson et al, 2001[9]	**No criteria definition**, just metabolic risk: BMI≥ 30mg/k2 BP >90/ 160 mmHg or using antihypertensive medication. FPG ≥126 mg/dl or DM TG >150 mg/dl HDL <35 mg/dl in men and <40 mg/dl in women.	**Day shift or shift work**: none specification	Sex, age, socioeconomic situation.	-	The relative risks for shift working versus day working women with one, two, and three metabolic variables were 1.06, 1.20, and 1.71, respectively. The corresponding relative risks for men were 0.99, 1.30, and 1.63, respectively.
Li et al,2011[26]	**No criteria definition**; presence of 3 of the five components: 1)BMI ≥30 kg/m2 2) BP≥130/85 mmHg 3) TG≥ 150 mg/dl 4)HDL: female HDL< 50mg/dl and male <40 5)FPG ≥110 mg/dl	**Day shift** or **shift work** : none specification	Smoking, alcohol consumption, leisure-time physical activity, work intensity, sleep duration, vegetable intake, and snack food habits.	-	The odds ratio for shift work was 1.87 ($CI_{95\%}$, 1.13 to 3.08; $p = 0.015$)

MetS= Metabolic Syndrome; BMI= Body Mass Index; TG= triglycerides; DM= Diabetes; HDL-c = HDL cholesterol; FPG= Fast plasma glucose; BP= blood pressure; NCEP ATPIII = National Cholesterol Education Program's Adult Treatment Panel III; IDF= International Diabetes Federation.

PARTE II

Artigo Original I:

SLEEP DEPRIVATION AND OBESITY IN SHIFT WORKERS IN SOUTHERN BRAZIL

SLEEP DEPRIVATION AND OBESITY IN SHIFT WORKERS IN SOUTHERN BRAZIL

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ABSTRACT

OBJECTIVE: The objective of our study was to explore the association between sleep deprivation and obesity among shift workers.

METHOD: A cross-sectional study was conducted on 905 shift workers among a poultry processing plant in southern Brazil. Obesity was defined as body mass index ≥ 30 kg/m^2. Time of sleep was categorized as: > 5 hours continuous/day; <= 5 hours continuous/day with some additional rest (sleep deprivation level I); and <= 5 hours/day without any additional rest (sleep deprivation level II). Others sociodemographic, heritability and behavioral characteristic variables were evaluated by means of a standardized pre-tested questionnaire. Potential confounding factors in the multivariable model were based on a conceptual framework.

RESULTS: Sleep deprivation levels I and II were associated with increased income, number of meals consumed throughout the day and nightshift work. All of the workers who exhibited a degree of sleep deprivation worked the night shift. After controlling, the prevalence ratios of obesity were 1,32 (95% CI 0,84;

2,08) and 4,57 (95% CI: 2,51; 8,32) in the workers with sleep deprivation levels I and II, respectively, compared to the reference group.

CONCLUSION: These results show a strong association between sleep deprivation and obesity in shift workers, and that sleep deprivation may be a direct consequence of working at night.

KEYWORDS: Obesity, Sleep deprivation, Sleep Disorders, Shift work, Night work

INTRODUCTION

Shift work, including night work, is becoming increasingly prevalent worldwide. According to the results of a survey conducted in 2005[1], more than 17% of the European Union working population are night shift workers, with significant variation among the countries (from 6,4% to 30,0%).

Many health impairments associated with shift work have been reported, but the most prevalent problem for the night shift worker is the quantity and quality of sleep.[2-4] Recently, a number of studies have correlated short sleep duration with a higher body mass index (BMI) in shift workers.[5-7] Other disorders caused by sleep deprivation include cardiovascular system disorders (hypertension and ischemic heart disease) [8-10] and metabolic disturbances, such as insulin resistance and metabolic syndrome.[11-13]

The number of people who are obese and overweight is increasing worldwide,[14] including in Brazil. Recent data from the Family Budget Survey, carried out between 2008 and 2009, showed that being overweight or obese is a public health problem in Brazil, affecting approximately 50% of adults over the age of 20 years.[15]

The mechanisms by which sleep restriction might affect weight are unclear. Restricted sleep may lead to daytime fatigue, therefore reducing activity and increasing hunger. In addition, experimental studies suggest that sleep deprivation can cause hormonal alterations, resulting in increased hunger and appetite.[5]

The objective of our study was to explore the association between sleep deprivation and obesity. The study was conducted among the employees of a poultry-processing plant in southern Brazil that functions 24 hours per day.

METHODS

The study was conducted among the employees of a large poultry-processing plant located in southern Brazil that functions 24 hours per day. The cross-sectional study included workers of 18 to 50 years of age who had been working fixed shifts for more than 6 months on the plant production line. Pregnant women and employees who had not worked for more than 10 days were excluded from the sample.

Sample size was calculated based on the 95% confidence interval (CI), a statistical power of 80%, an exposed to non-exposed ratio of 1:2, and a risk ratio of 1.30. Dayshift workers were defined as non-exposed and nightshift workers were defined as exposed. With the expectation of a 10% loss of the sample, the estimated necessary sample size was 1125 employees. For logistical reasons, all the employees living in the municipality where the company was headquartered (n = 1013) and in the two closest municipalities (n = 235) were included in the sample, for a total of 1278 workers. However, workers without height and weight measurements were excluded, leaving a final sample size of 905 workers. The characteristics of workers in the final sample (905) (sex, age, work shift, number of days in the shift, and sleep duration) were compared to the excluded workers. Only age and work shift showed a statistically significant difference.

Sociodemographic, heritability, behavioral and sleep characteristics were evaluated using a standardized pre-tested questionnaire. All interviews were conducted in the workers' homes between January and May 2010. The sociodemographic variables were age (continuous variable categorized into quintiles), skin color (self-reported by the interviewees and categorized as 'white' or 'other'), marital status (classified as 'having a partner' or 'not having a partner'), years of education (categorized as '1-4 years of elementary school', '5-8 years of elementary school', 'did not complete high school', or 'completed high school and higher'), and total family income (continuous data categorized into quartiles). The heritability of obesity was evaluated using parental overweight status as reported by the interviewee and categorized as obesity in ‘neither parent’, ‘one parent’, or ‘both parents’. The behavioral variables were: leisure physical activity (active individuals doing ≥ 150 minutes/week of physical activity and inactive individuals < 150 minutes/week) and the number of meals per day (one to two meals, three meals, or four or more meals). Sleep deprivation was measured by hours of sleep and categorized as >5 continuous hours/day, ≤5 continuous hours/day with some additional rest (sleep deprivation level I), and ≤ 5 hours/day without any additional rest (sleep deprivation level II).

The work schedule was provided by the company and confirmed by the workers through a questionnaire. Those who worked more than 90% of their hours in the evening or night were considered to be exposed (i.e., those who started their shift after 5:00 p.m.).Dayshift workers who started their working hours between 6:00 a.m. and 2:15 p.m. were considered to be non-exposed.

Obesity was assessed by body mass index (BMI), which was calculated by dividing the weight in kilograms by the square of the height in meters. Weight measurements (kg) were made using a Fantasy Sunrise balance with scale increments of 100 g, and height measurements (cm) were obtained using a Seca Bodimeter 208 portable stadiometer with scale increments of 1 mm. The BMI cutoff point for obesity was ≥ 30 kg/m^2.

Data were entered into Epidata software with double data entry. Data analysis was performed using STATA version 10 (StataCorp. College Station, TX, USA). Estimates for crude and adjusted prevalence ratios with 95% confidence intervals were calculated by modified Poisson regression with robust variance. Model 1 was unadjusted. Model 2 was adjusted for demographic and socioeconomic variables. Model 3 was adjusted for model 2 and parental overweight status. Model 4 was adjusted for models 2 and 3 and behavioral variables (physical activity, meals/day and work shift). Variables were retained in models as potential confounding factors if they had a p-value < 0.20.

This project was approved by the Research Ethics Committee of the University of Vale do Rio dos Sinos, RS, Brazil, as recommended by resolution 196/96, which relates to human research.

RESULTS

The average age of the participants was 31 (standard deviation = 8,7), and 63% were female. The average time of employment in the same work shift was 3,5 years for the dayshift workers and 3,6 years for the nightshift workers.

A total of 10,8% of the workers were obese (95% CI: 8,7 – 12,8). The prevalence of sleep deprivation levels I and II were 18,% (95% CI: 16,0 – 20,3) and 1,8% (95% CI 1,1 – 2,5), respectively. Table 1 shows the prevalence of sleep deprivation levels I and II and obesity in the workers according to sociodemographic characteristics, parental excess weight, behavioral traits and work shift. Sleep deprivation levels I and II were associated with increased income, number of meals consumed throughout the day and nightshift work. All of the workers who exhibited a degree of sleep deprivation worked the night shift. Obesity was more prevalent in the participants who were female, age 40 and older, had less schooling and reported excess weight in both parents.

Table 2 describes the association between the different levels of sleep deprivation and obesity based on prevalence ratios and the corresponding confidence intervals. The workers who reported a degree of sleep deprivation had a higher prevalence of obesity, which is an independent effect that increased after adjusting for possible confounding factors. After controlling for sociodemographic characteristics, parental excess weight, behavioral traits and work shift, the prevalence ratios were 1,32 (95% CI 0,84; 2,08) and 4.57 (95% CI: 2,51; 8,32) in the workers with sleep deprivation levels I and II, respectively, compared to the reference group.

DISCUSSION

These results show a positive correlation between sleep deprivation and obesity in shift workers after controlling for possible confounding factors. The workers with sleep deprivation level II (less than five continuous hours of sleep per day without additional rest) were 4.6 times more likely to be obese compared to the reference group (more than five continuous hours of sleep).

Several studies conducted in different populations have reported similar findings. In a systematic review of observational studies, Patel and Hu concluded that there is an independent correlation between shortened sleep duration and weight gain.[6] Gangwish et al. analyzed longitudinal data from the National Health and Nutrition Examination Survey (NHANES I) and found that the individuals who reported sleeping less than six hours per night had a higher BMI compared to the individuals who slept more than six hours per night.[16] Patel et al. followed 68,183 women for 16 years as a part of the Nurses' Health Study and found a dose-response correlation between sleep duration and weight gain, with the greatest average weight gain being observed in the women who slept five hours or less.[17] In Brazil, Moreno et al. described a greater prevalence of obesity in truck drivers who slept less than eight hours per night.[3]

The mechanisms that link sleep deprivation to weight gain are still not clear. Acute exposure to sleep deprivation in humans is associated with thermoregulatory effects and is related with a reduction in the total energy expenditure.[18,19] Individuals with sleep deprivation may increase their total caloric intake due to the impact of sleep deprivation on the peripheral regulators of satiety. Several studies have correlated sleep deprivation with reduced leptin and increased ghrelin levels and a consequent increase in appetite and weight gain.[5, 20]

In the present study, the only behavioral trait associated with sleep deprivation was the number of meals consumed throughout the day. Intake of four or more meals was associated with sleep deprivation level I, while intake of two or fewer meals was correlated with sleep deprivation level II. Because the present study was cross-sectional, it is not possible to establish whether sleep deprivation influenced the number of meals consumed by the workers during the day or whether nutritional aspects led to sleep issues. However, reduced sleep duration is known to have consequences on the social routine and lifestyle in individuals, particularly regarding dietary habits and level of physical activity. Although the influence of shortened sleep duration on dietary habits has not been well described in the literature, an increase in total energy consumption and a tendency to skip meals appears to be involved.[17, 18, 19, 23]

Sleep deprivation is one of the main consequences of shift work.[24] In the present study, all of the workers who exhibited a level of sleep deprivation worked the night shift, which is characterized by being awake during periods that are physiologically allocated for sleep. Thus, it is difficult to distinguish between the role of sleep deprivation and night shift work on weight gain in this population because the observed weight gain could be due to a shortened sleep duration and disruption of the circadian rhythm. A recent systematic review investigated the effects of shift work on weight gain and found strong evidence indicating that shift work is an independent risk factor for weight gain. However, none of the articles included in that review investigated duration of sleep in the participants.[27] Canuto et al. suggested evaluating sleep deprivation as a possible factor to mediate the association between shift work and metabolic disorders.[28]

The workers who reported greater income level increased levels of sleep deprivation. One hypothesis is that these individuals work double shifts to increase their income. In addition to the nightshift job, they have another job during the day that prevents longer sleep duration. Our study measured the family income but did not investigate the workers' specific earnings.

These results must be interpreted within the context of several limitations. Because it was a cross-sectional study, exposure and disease were measured concurrently, and it is difficult to assess whether sleep deprivation led to obesity or obesity induced the development of sleep disorders. This study was conducted with fixed shift workers and cannot be extrapolated to rotating shift workers. The classification of different levels of sleep deprivation may be considered arbitrary because the definition of normal sleep duration varies from six to nine hours per day. However, metabolic disorders and weight gain have been observed in individuals who sleep less than six hours per night.[17, 20]

These results show a strong association between sleep deprivation and obesity in shift workers. The present study contributes to understanding the risk factors for sleep deprivation in shift workers and shows that sleep deprivation may be a direct consequence of working at night. Future studies with different methodological designs and populations should be conducted to understand better the correlations between shift work, sleep deprivation and excessive weight gain.

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CONFLICT OF INTEREST

The funders had no role in the study design, data collection and analysis, decision to publish and preparation or approval of the manuscript.

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Table 1. Prevalence and interval confidence of obesity* and sleep deprivation level I and II**, according to sociodemographic, hereditary and behavioral characteristics among shift workers in southern Brazil (n = 905).

Variables	Obesity	p†	Sleep deprivation I	Sleep deprivation II	p†
	% (95% IC)		% (95% IC)	% (95% IC)	
Sex		0,016			0,342
Male (304)	7,2 (4,3 – 10,1)		16,4 (14,1 – 21,6)	1,0 (0,1 – 3,4)	
Female (601)	12,4 (9,8 – 15,1)		18,8 (15,7 – 21,3)	2,0 (1,0 – 3,2)	
Age		0,001			0,585
18 to 22 (164)	5,4(1,9 – 9,0)		16,3 (12,0 – 21,5)	2,4 (0,1 – 5,1)	
23 to 36 (189)	7,9 (4,0 – 11,8)		20,1 (15,4 – 25,6)	1,1(0,0 – 3,4)	
27 to 31 (158)	12,6 (7,4 – 17,8)		16,9 (12,2 – 22,6)	1,8 (0,1 – 4,6)	
32 to 39 (209)	11,0 (6,7 – 15,2)		22,0 (17,0 – 27,6)	1,2 (0,2 – 3,5)	
40 to 50 (185)	16,2 (10,8 – 21,6)		10,7(7,1 – 15,4)	2,6(0,1 – 0,5)	
Marital status		0,053			0,085
Without partner (273)	7,7 (4,5 – 10,8)		13,9(10,0 – 18,0)	2,2(0,1 – 4,7)	
With partner (632)	12,0 (9,4 – 14,5)		19,7(16,7 – 23,1)	1,4(0,1 – 2,6)	
Skin color		0,751			0,494
White (773)	10,6 (0,8 – 12,7)		17,6(15,0 – 20,4)	3,5(2,3 – 5,0)	
Other(132)	11,5 (5,9 – 17,1)		20,8(14,1 – 28,7)	0,1(0,0 – 4,2)	
Schooling		0,007			0,596
1 to 4 years (116)	15,6 (10,0 – 21,2)		18,7(13,0 – 25,4)	1,8(0,1 – 5,2)	
5 to 8 years (228)	12,3 (8,0 – 16,5)		15,3(10,9 – 20,7)	1,3(0,0 – 3,8)	
High school incomplete (72)	6,9 (0,9 – 13,0)		12,5 (5,8 – 22,4)	2,7(0,3 – 9,6)	
High school completed (435)	8,4 (5,8 – 11,0)		20,1(16,4 – 24,1)	1,6(0,1 – 3,2)	
Income (quarters)		0,323			0,042
I (208)	8,2 (4,4 – 11,9)		13,9(9,5 – 19,4)	1,0(0,0 – 3,4)	
II (223)	9,8 (5,9 – 13, 8)		18,8(14,0 – 24,6)	1,8(0,1 – 4,5)	
III (235)	14,0 (9,5 – 18,5)		18,3(13,5 – 23,8)	1,3 (0,0 – 3,6)	
IV (228)	10,5 (6,5 – 14,5)		21,0(16,0 – 27,0)	2,2 (0,1 – 5,0)	
Parents' overweight		<0,001			0,793
No (669)	7,0 (5,1 – 8,9)		18,1(15,2 – 21,2)	1,5(0,1 – 2,7)	
Yes (father or mother) (193)	19,7 (14,2 – 25, 3)		16,1(11,2 – 22,0)	2,1(0,1 – 5,2)	
Yes (father and mother) (39)	28,2 (13,4 – 43,0)		23,1(11,1 – 39,3)	2,6(0,0 – 13,5)	

Physical activity			0,951			0,447
Inactive (581)	10,6 (8,1 – 13,2)			16,9(13,9 – 20,1)	1,5(0,1 – 2,9)	
Active (324)	10,8 (7,4 – 14,2)			20,1(15,8 – 24,8)	1,8(0,1 – 4,0)	
Work shift			0,526			<0,001
Day (325)	9,8 (6,6 – 13,1)			0	0	
Night (580)	11,2 (8,6 – 13,8)			28,1(24,4 – 32,0)	2,6(1,4 – 4,2)	
Meals/day			0,291			<0,001
1 or 2 (154)	15,6 (10,0 – 21,2)			13,6(8,6 – 20,1)	2,6(0,1 - 6,5)	
3 (459)	12,3 (8,0 – 16,5)			14,1(11,1 – 17,7)	1,3(0,1 – 2,8)	
4 or more (292)	8,2 (5,8 – 10,6)			26,4(21,4 – 31,9)	1,7(0,0 – 3,9)	

***** BMI ≥ 30 Kg/m^2; ****** Sleep deprivation level I: sleep ≤ 5 hours continuous/day more some additional rest; Sleep deprivation level II: sleep ≤ 5 hours/day without any additional rest; **†** Chi-scare test

Table 2. Crude and adjusted prevalence ratios of obesity (BMI≥30) on sleep deprivation according to the sociodemographic and behavioral characteristics of shift workers in southern Brazil (n = 905).

Sleep	**Model 1**	**Model 2**	**Model 3**	**Model 4**
	0,002*	0,003*	0,002*	0,003*
Reference category	1	1	1	1
Sleep deprivation level I	1,27(0,80 – 2,00)	1,27(0,78 – 2,01)	1,27(0,80 – 2,00)	1,32(0,84 – 2,08)
Sleep deprivation level II	4,84(2,7 – 8,70)	4,85(2,23 – 10,05)	4,63(2,56 - 8,35)	4,57(2,51 – 8,32)

Model 1: crude analyses; Model 2: adjusted for demographic and socioeconomic variables; Model 3: adjusted for model 2 and parents' overweight; Model 4: adjusted for models 2 e 3 and behavioral variables.
* p-value in wald test

PARTE III

Artigo Original II

FATORES ASSOCIADOS À SÍNDROME METABÓLICA EM TRABALHADORES DE TURNOS

FATORES ASSOCIADOS À SÍNDROME METABÓLICA EM TRABALHADORES DE TURNOS

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RESUMO

OBJETIVO: Este estudo investigou a prevalência de síndrome metabólica (SM) e a sua associação com fatores demográficos, socioeconômicos e comportamentais em trabalhadores de turnos.

MÉTODOS: Foi conduzido um estudo transversal com uma amostra de 902 trabalhadores de turno de ambos os sexos de um frigorifico do Sul do Brasil. O diagnóstico da SM foi realizado de acordo com as recomendações do "*Harmonizing the Metabolic Syndrome*", e sua presença foi avaliada de acordo com as características demográficas, socioeconômicas e comportamentais da amostra. A análise multivariável seguiu um modelo teórico de determinação da SM em trabalhadores de turnos.

RESULTADOS: A prevalência de SM na amostra foi 9,3% ($IC_{95\%:}$ 7,4 – 11,2), sendo o componente alterado mais prevalente a circunferência da cintura (RP 48,4; $IC_{95\%}$ 45,5 – 51,2). Após o ajuste, a prevalência de SM mostrou-se positivamente relacionada às mulheres (RP 2,16; $IC_{95\%}$1,28 – 3,64), trabalhadores com mais de 40 anos (RP 3,90; $IC_{95\%:}$1,78 – 8,93) e que relataram dormir cinco ou menos horas por dia (RP 1,70; $IC_{95\%:}$ 1,09 – 2,24). Por outro lado, a SM mostrou-se negativamente relacionada ao maior nível de instrução (RP 0,55; C 0,29 – 1,06) e a realizar mais do que três refeições por dia (RP 0,43 $IC_{95\%}$ 0,26 – 0,73).

CONCLUSÃO: Sexo, idade, escolaridade, hábitos alimentares e duração do sono mostraram-se como fatores de risco independentes para a SM.

PALAVRAS-CHAVE: Síndrome metabólica,Trabalho em turnos, Trabalho noturno, Sono

ABSTRACT

OBJECTIVE: *this study investigated the prevalence of metabolic syndrome (MS) and its association with demographic, socioeconomic and behavioral factors in shift workers.*

METHODS: *a cross-sectional study was conducted on a sample of 902 shift workers of both sexes in a poultry processing plant in Southern Brazil. The diagnosis of SM was determined according to the recommendations from "Harmonizing the Metabolic Syndrome"; and its distribution was evaluated according to the demographic, socioeconomic and behavioral characteristics of the sample. The m*ultivariate analysis followed a theoretical framework for determining MS on shift workers.

RESULTS: *the prevalence of MS on the sample was 9,3% (IC$_{95\%:}$ 7,4 – 11,2). The most frequent altered component was waist circumference (RP 48,4; IC$_{95\%}$ 45,5 – 51,2). After adjustment, the prevalence of MS was positively associated with women (RP 2,16; IC$_{95\%}$1,28 – 3,64), workers of over 40 years of age (RP 3,90; IC$_{95\%:}$1,78 – 8,93) and those who reported sleeping five or less hours per day (RP 1,70; IC$_{95\%:}$ 1,09 – 2,24). On the other hand, MS was negatively correlated with higher educational level (RP 0,55; C 0,29 – 1,06) and having more than three meals per day (RP 0,43 IC$_{95\%}$ 0,26 – 0,73).*

CONCLUSION: *sex, age, educational level, eating habits and duration of sleep appeared as independent risk factors for MS.*

KEYWORDS*: Metabolic Syndrome X, Shift work, Night work, Sleep*

INTRODUÇÃO

A síndrome metabólica (SM) é um conjunto de alterações metabólicas, que inclui alterações glicêmicas, aumento da pressão arterial, níveis elevados de triglicérides, lipoproteínas de alta densidade e obesidade abdominal[1], que está associada ao aumento do risco de desenvolvimento de diabete melito tipo 2, doenças cardiovasculares e ao aumento da mortalidade geral.[2, 3]

O aumento da prevalência da SM em todo o mundo tem sido atribuído às mudanças nos hábitos de vida dos indivíduos, principalmente aos novos padrões de alimentação e ao sedentarismo.[4-6] No entanto, a vida moderna trouxe igualmente mudanças no âmbito do trabalho. As jornadas de trabalho que até então eram diurnas, agora, em alguns casos, se estendem pelas 24 horas do dia. Estima-se que, em alguns países europeus, até 30% dos trabalhadores estejam expostos ao regime de turnos. Com isso, a partir da última década, estudos têm investigado a relação entre o trabalho em turnos e a SM,[7-9] evidenciando um aumento de até 5 vezes no risco de desenvolver SM entre os trabalhadores de turnos, quando comparados aos trabalhadores do turno diurno.[10] Nesse sentido, recente revisão sistemática de estudos observacionais sobre o tema concluiu que ainda não existem evidências suficientes que comprovem a relação entre trabalho em turnos e SM. Os autores ainda destacam a importância da investigação de outros fatores de risco que possam estar envolvidas na complexa cadeia causal que liga o trabalho em turnos à SM.[11]

Assim, este estudo investigou a prevalência de SM e seus componentes alterados e as suas relações com fatores demográficos, socioeconômicos e comportamentais em trabalhadores de turnos.

MÉTODOS:

Este estudo foi conduzido com trabalhadores da área de produção de um frigorífico de frango localizado no Sul do Brasil, que funciona durante as 24 horas do dia. Trata-se de um estudo transversal realizado com trabalhadores entre 18 e 50 anos de idade de ambos os sexos. Foram excluídos da amostra aqueles que trabalhavam na empresa a menos de 6 meses, gestantes e trabalhadores afastados da empresa a mais de 10 dias.

O tamanho da amostra inicial foi calculado para o desfecho obesidade e para a exposição trabalho em turnos, totalizando um tamanho de amostra de 1278 trabalhadores.[12] Porém, a amostra final deste estudo foi composta por 902 trabalhadores, sendo, assim, realizado um cálculo de poder *a posteriori*. Considerando-se um poder 80% e uma significância de 5%, esta amostra teve poder para mostrar diferenças de 75% na razão de prevalência de SM entre os trabalhadores diurnos e noturnos.

O diagnóstico da SM foi realizado de acordo com as recomendações do documento "Harmonizing the Metabolic Syndrome".[1] Dessa forma, foram classificados como portadores de SM os trabalhadores que possuíam pelo menos três das seguintes medidas: circunferência da cintura (CC) nos homens ≥ 94 cm e nas mulheres ≥80 cm (ponto de coorte utilizado devido a população ser de descendência alemã); pressão arterial (PA) PS/PD ≥ 130/85 mmHg ou presença de hipertensão arterial (HAS) diagnosticada por um médico; HDL-colesterol (HDL) em homens <40 mg/dl e em mulheres <50 mg/dl; triglicerídeos (TG) ≥150mg/dl e glicose de jejum (GL) ≥ 100 mg/dl ou presença de diabete melito tipo 2 (DM2) diagnosticada por um médico. Além disso, cada um dos componentes foi classificado como alterado a partir destes pontos de corte e suas distribuições na amostra foram investigadas.

A medida de CC foi realizada no ponto médio entre o último arco costal e a crista ilíaca, utilizando-se fita métrica inextensível com precisão de 1mm; a medida foi realizada duas vezes, sendo considerada a média das duas medidas. A PA foi aferida duas vezes e considerada a sua média; foi utilizado o aparelho automático digital marca (OMRON modelo HEM 711 ACINT). Para mensurar o *HDL, TG e GL* foram amostras do sangue venoso da veia cubital do antebraço, após jejum de 12 horas, em um laboratório de análises bioquímicas da região onde residiam os trabalhadores do frigorífico.

As informações sobre os turnos de trabalho foram coletadas junto à empresa e confirmadas com os trabalhadores no momento da entrevista. Os turnos foram categorizados em diurno e noturno, sendo considerados expostos os trabalhadores que realizavam mais de 90% da jornada no turno da noite/madrugada, ou seja, que iniciavam a jornada de trabalho às 17 horas, e não expostos os trabalhadores do turno diurno que iniciavam sua jornada às 6 horas da manhã. O horário de trabalho da indústria era de 44 h/ semana, tendo os trabalhadores um dia de folga, podendo ser realizado no sábado ou no domingo.

Na coleta das informações demográficas, socioeconômicas e comportamentais foi utilizado um questionário estruturado, padronizado e pré-codificado; as entrevistas foram realizadas no domicílio do trabalhador por entrevistadores treinados. As variáveis sociodemográficas investigadas foram: sexo (feminino; masculino), cor da pele referida e categorizada em branco e não branco, estado civil (sem companheiro; com companheiro) e a idade coletada em anos completos e categorizada em quintis. As variáveis socioeconômicas investigadas foram: escolaridade (1º a 4º ano do ensino fundamental; 5º a 8º ano do ensino fundamental; ensino médio incompleto; ensino médio completo ou mais) e renda, coletada em renda familiar e categorizada em quartis de renda per capita. As variáveis comportamentais mensuradas foram: a prática de atividade física de lazer, categorizada em ativos (>=150 min/semana) e inativos (<150min/semana), tabagismo (nunca fumou; ex-fumante; fumante), ingestão de bebidas alcoólicas coletada em quantidade e tipo de bebida consumida e categorizado conforme consumo diário de álcool (não bebe; leve a moderado: 15g/dia para mulheres e <30g/dia para homens; elevado: ≥15g/dia para mulheres e ≥ 30g/dia para homens)[13], número de refeições realizadas por dia (≤3 refeições/dia; >3 refeições/dia). Para contabilização do número de horas diárias de sono (<5 horas/≥5 horas) foi perguntado o horário que o trabalhador habitualmente dormia e acordava.

Os dados foram digitados no programa Epidata, com dupla entrada e, posterior, comparação. As análises estatísticas foram realizadas no programa STATA, versão 10. Na análise bivariada e na multivariada foi utilizada regressão de Poisson com variância robusta para o cálculo das razões de prevalência e seus respectivos intervalos de confiança de 95% (IC95%). Aquelas que apresentaram nível de significância maior do que 20% foram consideradas possíveis fatores de confusão e, assim, incluídas na análise multivariada. A análise multivariada seguiu um modelo conceitual definido *a priori.*[14] Nesse modelo, a decisão das variáveis a serem incluídas na análise seguiu a provável hierarquia entre elas na cadeia causal de determinação da SM entre trabalhadores de turnos. As variáveis foram ingressando no modelo multivariado conforme o nível de determinação (distal,intermediário e proximal). Aquelas pertencentes ao nível distal foram as primeiras incluídas no modelo, uma vez que atuariam sobre o desfecho, mas não seriam determinadas pelas variáveis intermediárias e proximais ao desfecho. Toda variável que apresentava um nível de significância estatística de $p \leq 0,20$ foi mantida no modelo e considerada um potencial fator de confusão para as variáveis do próximo nível de determinação. Assim, no primeiro nível foram incluídas as variáveis demográficas. No nível seguinte (2º nível), foram incluídas as variáveis socioeconômicas, além daquelas variáveis que apresentaram significância no nível superior (1º nível). No 3º nível, foram incluídas as variáveis comportamentais e aquelas potenciais fatores de confusão dos níveis superiores (i.e distal e intermediário). Por fim, foram consideradas associadas a SM aquelas variáveis que após o ajuste no modelo multivariado apresentaram $p \leq 0,05$. Adicionalmente, possíveis interações entre o turno de trabalhado e as demais variáveis comportamentais foram investigadas.

Este projeto respeitou todas as normas éticas de pesquisa com seres humanos, assim, foi submetido e aprovado pelo Comitê de Ética em Pesquisa da Universidade do Vale do Rio dos Sinos, como recomenda a resolução 196/96.

RESULTADOS:

A média de idade dos trabalhadores foi de 31 anos (DP = 8,7). A maior parte da amostra foi composta por mulheres (65,9%), trabalhadores noturnos (63%) e 48,0% dos trabalhadores haviam cursado até o segundo grau completo ou mais. A média de tempo trabalhando na empresa foi de 68 meses (DP= 58,0).

A prevalência de SM na amostra foi 9,3% ($IC_{95\%:}$ 7,4 – 11,2), sendo o componente alterado mais prevalente a CC, seguido do HDL. Na tabela 1, estão demonstradas as prevalências dos componentes alterados da SM de acordo com características sociodemográficas e comportamentais. Trabalhadores do sexo feminino apresentaram maiores prevalências de CC e HDL alterado e do sexo masculino de GL alterado. Observa-se, ainda, que trabalhadores mais jovens, com idade entre 18 a 22 anos, apresentavam maior prevalência de HDL alterado. Mas, os trabalhadores mais velhos tiveram as maiores prevalências de CC, PA e TG alterados; maiores prevalências desses três componentes alterados também foram observados naqueles com menor escolaridade. Por fim, características comportamentais, como menor número de refeições e menos horas de sono, estiveram associadas a maiores prevalências de CC, PA e TG alterados.

A tabela 2 mostra as prevalências de SM de acordo com as características da amostra, além das razões de prevalência brutas e ajustadas. Maiores prevalência de SM foram encontradas em trabalhadores com idade ≥ 40 anos (18%) e menores níveis de escolaridade (16%). Observou-se que, após o ajuste nos três níveis do modelo multivariado, as mulheres, trabalhadores com mais de 40 anos e que relataram dormir cinco ou menos horas por dia apresentaram maior probabilidade de ter SM. Por outro lado, os trabalhadores que apresentaram maior nível de instrução e realizavam mais do que três refeições por dia mostraram-se protegidos para a ocorrência de SM. Não houve interação entre as variáveis número de refeição e duração de sono no teste de homogeneidade.

A relação entre o turno de trabalho e a duração do sono também foi investigada; todos (100%) os trabalhadores que relataram dormir cinco ou menos horas por noite eram trabalhadores do turno noturno.

DISCUSSÃO

Este estudo investigou os fatores relacionados à SM e seus componentes alterados em trabalhadores de turnos de um frigorífico do Sul do Brasil. Nesta amostra, a ocorrência de SM esteve associada ao sexo, à idade, à escolaridade, aos hábitos alimentares e a duração do sono. Ao estudarmos os componentes alterados da SM de forma isolada, em sua maioria, às características sociodemográficas; enquanto, apenas, CC e a PA alteradas associaram-se às características comportamentais.

Os resultados relacionados às prevalências dos componentes alterados entre os trabalhadores de turnos corroboram com os achados de outros estudos de base populacional, [15-21] com exceção das prevalências HDL e GL alteradas. Tradicionalmente, níveis de HDL abaixo do recomendando têm sido associados ao aumento da idade, principalmente, entre as mulheres.[22-24] Porém, neste estudo, os maiores níveis de HDL alterado foram encontrados entre trabalhadores mais jovens (18 a 22 anos). Na literatura, são encontrados outros estudos recentes com resultados no mesmo sentido.[18, 19] Mesmo assim, levanta-se a possibilidade de causalidade reversa. Pode-se pensar que os trabalhadores mais velhos têm mais cuidados relacionados à saúde (alimentação e atividade física) quando comparadas aos mais jovens. [25, 26] Com relação à GL, maiores níveis alterados foram encontrados entre os homens e os trabalhadores na faixa etária de 32 a 39 anos. Contudo, o esperado seria uma maior prevalência de GL alterada entre os trabalhadores com mais de 40 anos, uma vez que a literatura indica o aumento dos níveis de glicose sanguínea relacionados ao aumento da idade.[19, 20] Assim, uma hipótese para esse achado é que os trabalhadores mais jovens (32 a 39 anos) poderiam estar menos atentas às alterações na glicose em relação aos trabalhadores com mais de 40 anos.

Os componentes alterados com maiores prevalência entre os trabalhadores deste estudo foram CC, HDL e PA, sucessivamente. Outros estudos com trabalhadores de turnos encontraram resultados controversos: Pietrousti *et al* encontrou como componente alterado mais incidente HDL e TG, seguido de PA, CC e GL;[10] Violanti encontrou maiores prevalências de HDL alterados, seguido da CC, da GL, da PA e dos TG.[27] Além disso, neste estudo quase metade (48,4%) dos trabalhadores apresentaram CC acima do recomendado (≥80cm), mesmo tratando-se de uma amostra composta por trabalhadores jovens (média idade 31 anos). Outros estudos conduzidos entre trabalhadores, que utilizaram o mesmo ponto de coorte para CC alterada, encontraram prevalências variando entre 11,2% e 30,6%.[10, 27, 28] Já um estudo de base populacional conduzido recentemente no Brasil, encontrou uma prevalência de CC acima do normal de 51,4%.[29] Outro componente da SM que mostrou-se alterado em mais de 30% dos trabalhadores foi o HDL. Esse achado corrobora com os estudos de Pietrousti *et al* e *Violanti et al,* que descrevem o HDL como o componente da SM mais frequentemente alterado em seus estudos.[10, 27] Prevalências semelhantes de HDL abaixo do recomendado foram encontradas em estudos de base populacional, dentre eles o NHANES III.[30]

Também foi objetivo deste estudo investigar os fatores associados à SM em trabalhadores de turnos. Nesse sentido, recentemente, alguns autores têm chamado a atenção para a importância do controle de possíveis fatores de confusão e modificadores de efeito em estudos que investigam a relação entre o trabalho em turnos e as doenças crônicos não-transmissíveis, como a SM. [11, 31] Por isso, este estudo propôs um modelo conceitual definido a *priori*, que levou em consideração as variáveis distais, intermediárias e proximais relacionadas ao desfecho As variáveis ingressadas em cada nível de determinação foram controladas para as do mesmo nível e, quando apropriado, para as dos níveis superiores. Dessa forma, a influência de potencias fatores de confusão, como características demográficas, socioeconômicas e comportamentais, foi controlada quando necessário. Além disso, foram realizados testes de interação estatística para detecção de possíveis variáveis modificadoras de efeito.

Desse modo, maiores prevalências de SM foram encontradas entre trabalhadores mais velhos e com menor escolaridade. Dois estudos anteriores com trabalhadores de turnos também relataram a idade diretamente associada à SM.[7, 32] Entretanto, este é o primeiro estudo que investiga variáveis sociodemográficas e SM em trabalhadores de turno. Estudos com essa temática foram conduzidos apenas na população em geral, encontrando, da mesma forma, maiores prevalências de SM entre as mulheres com menores níveis educacionais.[15, 19, 30, 33]

O desenvolvimento de SM também é fortemente influenciado pelas características comportamentais dos indivíduos. Contundo, entre os fatores comportamentais investigados neste estudo, apenas o número de refeições realizadas durante o dia e a duração do sono estiveram relacionados a SM. Os trabalhadores que realizavam um maior número de refeições mostraram-se protegidos para a SM. Interação estatística entre o número de refeições e o turno de trabalho foi testada, mas não foi encontrada associação. Esquirol et al. realizaram uma investigação semelhante entre trabalhadores de turnos na França e encontraram resultados na mesma direção. Os trabalhadores que realizavam, além do almoço e jantar, o café da manhã, lanche da tarde e lanche da noite apresentaram menores prevalências de SM quando comparados aos que não realizavam as mesmas refeições.[7] Uma possível explicação fisiológica para isso é o fato que realizar refeições com maior frequência leva ao melhor controle do apetite, ao maior efeito da termogênese pós-prandial, a maior mobilização de lipídios, devido aos repetidos estímulos do sistema nervoso simpático, a menor elevação da glicose plasmática e a menores variações nos níveis de insulina e do peptídeo C.[34, 35]

Já a associação entre duração do sono, turno de trabalho e distúrbios metabólicos tem sido o alvo de diversos estudos observacionais na última década. Porém, devido à maioria dos estudos não incluírem o sono em seus modelos de análises, ainda não é possível determinar se o sono é um fator de confusão, uma variável modificadora de efeito ou um mediador no caminho causal que liga o trabalho em turnos à SM.[11] Cabe ressaltar que os três estudos identificados que investigaram essa relação, tratando o sono como fator de confusão, obtiveram resultados controversos: dois encontraram efeitos negativos do trabalho em turnos na SM [27, 28] e o outro encontrou efeito protetor no trabalho rotativo na sua ocorrência.[32] No nosso estudo, os trabalhadores que dormiam cinco ou menos horas por dia apresentaram maiores prevalências de SM, além disso, todos eles eram trabalhadores do turno noturno. Assim, parece que o trabalho noturno levou à privação de sono entre estes trabalhadores, sugerindo que o sono seria um fator mediador na relação entre trabalho noturno e SM.

A regulação hormonal que ocorre durante o sono e seus múltiplos efeitos periféricos depende da duração e qualidade deste, indicando que a perda de sono tem efeitos deletérios à saúde. Assim, estudos observacionais e experimentais têm documento o encurtamento do sono como um fator de risco independente na ocorrência de SM.[36] Wu et al. demonstraram que o tempo diminuído de sono (<6 horas/dia) foi positivamente associado a SM. Adicionalmente, a diminuição do tempo de sono tem sido relacionada a diversos distúrbios metabólicos, como à intolerância à glicose, resistência à insulina, dislipidemia, hipertensão arterial e a processos inflamatórios sistêmicos. [21, 37-40]

Nossos achados devem ser interpretados a luz de alguns aspectos. Primeiramente, este é um estudo de desenho transversal e, por isso, não é possível distinguir-se temporalidade entre a ocorrência das exposições e do desfecho. O conhecimento de seus parâmetros metabólicos alterados poderia ter levado os trabalhadores a mudanças de hábitos de vida. Segundo, esta pesquisa foi realizada entre trabalhadores de turnos fixos e seus achados não podem ser extrapolados para trabalhadores de turnos rotativos. Por fim, o fato de o estudo ter sido realizado com uma população de trabalhadores e, assim, estar suscetível ao efeito do trabalhador saudável, pode ter causado uma menor exposição dos indivíduos a comportamentos de risco, como se pode observar pelas baixas prevalências de tabagismos e ingestão de bebidas alcoólicas encontradas nesta amostra.

Finalmente, nosso estudo traz importantes contribuições para o entendimento de como os trabalhadores de turnos podem estar mais expostos ao desenvolvimento de distúrbios metabólicos do que a população em geral. Primeiro, por estudos com essa temática serem escassos. Segundo, por este ser o primeiro estudo com esta temática conduzido no Brasil. Outro aspecto inédito foi a proposta de conduzir as análises seguindo um modelo teórico definido *a priori.* Dessa forma, nosso estudo demonstrou que sexo, idade e escolaridade são fatores de risco para a ocorrência da SM. Além disso, a privação de sono pareceu ser um fator ligação entre trabalho noturno e SM. Ainda, os componentes da SM alterados mostraram-se associados, em sua maioria, às características sociodemográficas; enquanto, CC e a PA alteradas associaram-se apenas às características comportamentais. Para uma melhor elucidação do papel de cada uma das variáveis independentes na determinação da SM em trabalhadores de turnos, futuros estudos longitudinais que incluam todos os possíveis fatores de risco da sua determinação, inclusive duração e qualidade do sono, devem ser conduzidos.

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Tabela 1. Distribuição da prevalência e intervalos de confiança (IC95%) dos componentes da MetS alterados de acordo com a idade, escolaridade, hábitos alimentares e duração do sono. (n=902).

Variáveis	% (IC95%)				
	CC Masc ≥94cm Fem ≥80 cm	**HDL** Masc <40mg/dl Fem <50 mg/dl	**PA** ≥ 130/85 mmHg	**TG** ≥150mg/dl	**GL** 100 mg/dl
Total	48,4 (45,5 – 51,2)	33,8 (30,7 – 36,9)	12,8 (10,9 -14,7)	8,7(6,9 – 10,5)	4,2 (2,9 – 5,5)
Sexo	<0,001	<0,001	0,061	0,943	<0,001
Masculino	26,9 (22,6 – 31,2)	12,4 (8,6 – 16,1)	10,3 (7,4 -13,2)	8,8 (5,6 – 11,9)	6,1 (3,4 – 8,9)
Feminino	59,9 (56,4 - 63,3)	44,8 (40,8 – 48,7)	14,1 (11,6 - 16,5)	8,6 (6,3 – 10,9)	1,5 (0,5 – 2,5)
Idade (quintis)	<0,001	0,017	<0,001	<0,001	0,003
18 a 22 anos	32,7(26,8 – 38,5)	44,8(37,2 – 52,5)	2,4 (0,5 – 4,3)	5,4 (1,9 – 8,9)	0,6 (0,0 – 1,8)
23 a 26 anos	34,5 (28,6 – 40,3)	34,0 (27,2 – 40,8)	7,5 (4,2 – 10,7)	6,3 (2,8 – 9,7)	3,1 (0,6 – 5,6)
27 a 31 anos	49,1(42,4 – 55,8)	28,9 (21,8 – 36,0)	10,6 (6,5 – 14,7)	6,9 (2,9 – 10,9)	0,1(0 – 1,8)
32 a 39 anos	56,7 (50,5 – 62,9)	31,7 (25,3 - 38,1)	18,0 (2,5 – 13,2)	5,8 (2,6 – 9,1)	6,8(3,3 – 10,3)
≥40 anos	71,2 (65,4 – 77,1)	30,3 (23,6 – 36,9)	26,2(20,5 – 31,9)	18,6 (13,0 – 24,2)	3,2(0,6 – 5,7)
Escolaridade	<0,001	0,864	<0,001	0,012	0,691
1º a 4º ano	63,2 (56,7 – 69,7)	34,1 (26,8 – 41,4)	20,3 (14,2 – 25,7)	15,0 (9,5 – 20,4)	4,2 (1,1 – 7,2)
5º a 8º ano	56,9 (51,4 – 62,4)	34,3 (28,1 – 40,5)	16,3 (12,1 – 20,4)	8,7 (5,0 – 12,3)	3,0 (0,8 – 5,2)
Médio incompleto	36,5(27,1 – 45,9)	37,5 (26,4 – 48,9)	7,7 (2,5 – 12,9)	5,5 (2,7 – 11,0)	4,2 (0,0 – 8,9)
≥Médio completo	40,4 (36,4 – 44,4)	32,6 (28,2 – 37,0)	9,1 (6,7 – 11,4)	6,8(4,5 – 9,2)	2,5 (1,0 – 3,9)
Número de refeições	0,003	0,794	0,029	0,054	0,718
≤3	51,4 (47,9 – 54,8)	34,1 (30,3 – 37,8)	14,3 (11,8 – 16,7)	9,9 (7,6 – 12,3)	2,9 (1,6 – 4,3)
>3	42,4 (37,5 – 47,3)	33,2 (2,8 – 38,6)	9,8 (6,8 – 12,7)	6,1 (3,3 – 8,8)	3,4 (1,3 – 5,4)
Duração do sono	0,026	0,535	0,018	0,163	0,235
>5 horas	46,8 (43,7 – 50,0)	33,3 (29,9 – 36,7)	11,6 (9,6 – 13,7)	8,0(6,1 – 10,0)	3,4 (2,9 – 4,7)
≤ 5 horas	54,7 (48,4 – 61,1)	35,8 (28,6 – 42,9)	17,4 (12,5 – 22,2)	11,4 (6,6 – 16,1)	1,7 (0,0 – 3,6)

Tabela 2. Prevalências, razões de prevalência brutas e ajustadas de síndrome metabólica de acordo com características demográficas, socioeconômicas e comportamentais em trabalhares de turnos. (n=902).

Variáveis	n	Prevalência	Análise Bruta		Análise Ajustada	
		(IC95%)	RP (IC95%)	P valor	RP (IC95%)	P valor
1° NÍVEL						
Sexo				0,004		0,003
Masculino	307	5,2 (2,7 – 7,7)	1		1	
Feminino	595	11,4 (8,8 – 14,0)	2,20 (1,30 – 3,71)		2,16 (1,28 – 3,64)	
Estado civil				0,018		0,297
s/ companheiro	277	5,7 (3,0 – 8,5)	1		1	
c/ companheiro	625	10,9(8,4 – 13,3)	1,80 (1,11 – 3,19)		1,35 (0,80 – 2,30)	
Cor da pele				0,986		
Branco	772	9,3 (7,2 – 11,4)	1			
Não branco	128	9,4 (4,2 – 14,5)	1,01 (0,56 – 1,80)		-	
Idade (quintis)				< 0,001		<0,001
18 a 22 anos	164	4,2 (1,1 – 7,4)	1		1	
23 a 26 anos	189	5,3 (2,1 – 8,5)	1,24 (0,4 – 3,2)		1,21 (0,47 – 3,15)	
27 a 31 anos	159	6,9 (2,9 – 10,9)	1,62 (0,6 – 4,1)		1,57 (0,62 – 4,02)	
32 a 39 anos	202	10,4(6,1 – 14,6)	2,40 (1,1 – 5,6)		2,28 (1,00 – 5,27)	
≥40 anos	188	18 (13,0 – 24,2)	4,40 (2,0 – 9,5)		3,90 (1,78 – 8,93)	
2° NÍVEL						
Escolaridade				<0,001		0,047
1º a 4º ano	167	16,2 (10,5 – 21,8)	1		1	
5º a 8º ano	228	12,7 (8,4 – 17,1)	0,78 (0,48 – 1,27)		0,89 (0,54 – 1,48)	
Médio incompleto	72	4,2 (0,0 – 8,9)	0,25(0,08 – 0,82)		0,46 (0,13 – 1,57)	
≥Médio completo	434	5,7 (3,5 – 8,1)	0,35 (0,21 – 0,59)		0,55 (0,29 – 1,06)	
Renda per capita				0,080		0,053
Quartil I	206	7,28 (3,70 – 10,85)	1		1	
Quartil II	222	8,56 (4,85 – 12,23)	1,17 (0,61 – 2,25)		1,13 (0,60 – 2,12)	
Quartil III	234	9,40 (5,63 – 13,17)	1,29 (0,68 – 2,13)		1,25 (0,68 – 2,34)	
Quartil IV	229	12,22 (7,95 – 16,50)	1,67 (0,92 – 3,06)		1,73 (0,96 – 3,14)	
Turno de trabalho				0,575		
Diurno	326	8,5 (5,5 – 11,6)	1			
Noturno	576	9,7 (7,3 – 12, 1)	1,13 (0,73 – 1,74)		-	
3° NÍVEL						
Atividade física				0,848		
Inativo	582	9,4 (7,0 – 11,9)	1		-	
Ativo	320	9,1 (5,9 – 12,2)	0,96 (0,62 – 1,47)			
Tabagismo				0,449		
Nunca fumou	785	8,9 (6,9 – 10, 9)	1		-	
Ex-fumante	80	12,5 (5,1 – 19,9)	1,40 (0,75 – 2,6)			
Fumante	36	11,1 (0,3 – 21,8)	1,24 (0,48 – 3,2)			
Número de refeições				0,008		0,002
≤3	610	11,1 (8,6 – 13,6)	1		1	
>3	292	5,5 (2,8 – 8,1)	0,49 (0,29 – 0,83)		0,43 (0,26 – 0,73)	
Ingestão de álcool				0,213		
Não	321	10,9 (7,5 – 14,3)	1			
Moderado	552	8,5 (6,1 – 10,8)	0,78 (0,51 – 1,18)		-	
Excessivo	29	6,9 (0,0 – 16,7)	0,63 (0,16 – 2,5)			
Duração sono				0,041		0,017
> 5 horas	730	8,3 (6,3 – 10,3)	1		1	
≤ 5 horas	172	13,4 (8,2 – 18,5)	1,60 (1,02 – 2,51)		1,70(1,09 – 2,24)	

1° NÍVEL: demográficas (sexo, cor de pele, estado civil, idade)
2° NÍVEL: 1º nível + socioeconômicas (escolaridade, renda, turno de trabalho)
3° NÍVEL: as do 1º e 2º níveis + comportamentais (tabagismo, atividade física, consumo de bebida alcoólica, número de refeições/dia duração do sono)

CONSIDERAÇÕES FINAIS

O presente trabalho teve por objetivo investigar os fatores associados aos distúrbios metabólicos entre trabalhadores de turnos. Para tanto, foram conduzidos um artigo de revisão da literatura e dois artigos originais. A revisão da literatura teve foco na associação entre síndrome metabólica e trabalho em turnos. Já os artigos originais tiveram como foco os fatores associados à obesidade e à síndrome metabólica entre os trabalhadores de turnos.

Os achados relacionados ao desfecho obesidade mostraram que, após controle para possíveis fatores de confusão, os trabalhadores que relataram dormir cinco ou menos horas por dia e não realizar nenhum cochilo adicional tiveram uma probabilidade 4,6 vezes maior de serem obesos, quando comparados aos trabalhadores que dormiam mais de cinco horas por noite. Além disso, a privação de sono mostrou-se relacionada à maior renda, ao número de refeições realizadas durante o dia e ao trabalho noturno. Todos os trabalhadores que relataram privação de sono eram trabalhadores do turno noturno.

Adicionalmente, foram investigados os fatores relacionados à síndrome metabólica nos trabalhadores em turnos, demonstrando que a ocorrência da síndrome metabólica está associada ao sexo, à idade, à escolaridade, a um menor número de refeições realizadas ao longo do dia e à duração do sono. A síndrome metabólica não esteve associada ao turno de trabalho, mas, novamente, todos os trabalhadores que relatavam ter uma duração do sono diminuída eram trabalhadores do turno noturno. Ainda, os componentes da SM alterados mostraram-se associados, em sua maioria, às características sociodemográficas; enquanto, CC e a PA alteradas associaram-se apenas às características comportamentais (sono e alimentação).

A partir desses achados, pode-se pensar que a privação de sono seria um fator mediador na cadeia causal que leva os trabalhadores de turnos a desenvolverem distúrbios metabólicos, visto que ele foi, nesta amostra, uma consequência direta do trabalho noturno. Porém na literatura, sono e trabalho em turnos são investigados, na maioria, das vezes de forma separada. Um exemplo disso são revisões sistemáticas que investigam a associação do ganho excessivo de peso, tanto com a privação do sono,[6] como o trabalho em turnos [7], e ambos concluem que há uma relação independente entre exposição e o desfecho. Entretanto, não foi encontrada revisão sistemática que investigasse a associação entre trabalho em turnos e síndrome metabólica. Dessa forma foi objeto desse trabalhado realizar uma revisão sistemática com esse objetivo. Conclui-se, com esse trabalho, que não existem evidências suficientes que comprovem que o trabalho em turnos, seja ele noturno ou rotativo, é um fator de risco independente para a ocorrência de síndrome metabólica. Uma vez que, a maioria dos estudos incluídos nesta revisão não mediu a qualidade e/ou duração do sono dos trabalhadores e, assim, ainda não é possível determinar o papel do sono nessa relação, isto é se ele é um fator de confusão, uma variável modificadora de efeito ou um mediador.[9] Além disso, os três estudos recuperados que investigaram essa relação, tratando o sono como fator de confusão, obtiveram resultados controversos: dois encontraram efeitos negativos do trabalho em turnos na SM[10, 11] e o outro encontrou efeito protetor no trabalho rotativo na sua ocorrência.[12]

Dessa forma, ainda é controversa na literatura a relação entre trabalho em turnos, duração do sono e distúrbios metabólicos. Talvez isso se deva ao fato que esses trabalhadores estão expostos tanto a alterações do ritmo circadiano, por trabalhar em um momento do dia que fisiologicamente deveriam estar dormindo, como a privação do sono, como uma consequência direta do trabalho em turnos. A literatura científica tem explicado o impacto dessas duas exposições (trabalho em turnos e privação sono) na ocorrência dos distúrbios metabólicos de forma independente. Por um lado, todos os nossos processos metabólicos são relacionados ao sistema circadiano. No tecido adiposo, por exemplo, ao longo de um período de 24 horas, o adipócito deve p ajustar a taxa de síntese, armazenamento e degradação dos triglicerídeos. Alguns fatores específicos dos adipócitos também mostram uma expressão rítmica. Alguns exemplos são a leptina, adipsina, resistina e adiponectina. Adicionalmente, a ruptura do sistema circadiano conduz à desregulação do metabolismo da glicose, e essas resposta disfuncional pode contribuir também para fisiopatologia dos distúrbios metabólicos.[13, 14] Por outro lado, a exposição aguda à privação do sono em humanos está associada a alterações na termorregulação, ou seja, a redução do total do gasto energético. Além disso, indivíduos com privação de sono pode aumentar sua ingestão calórica total, devido ao impacto da privação de sono sobre os reguladores periféricos de saciedade, estudos têm relacionado a privação do sono com redução nos níveis de leptina e grelina aumentada e um consequente aumento do apetite e ganho de peso.[5, 15-18]

Por fim, nossos achados levantam a hipótese da possível relação entre trabalho em turnos, duração do sono e distúrbios metabólicos, sendo a privação de sono um possível fator mediador nessa relação. Entretanto, para uma melhor elucidação do papel de cada uma das variáveis independentes na determinação dos distúrbios metabólicos em trabalhadores de turnos, futuros estudos longitudinais que incluam todos os possíveis fatores de risco da sua determinação, inclusive duração e qualidade do sono, devem ser conduzidos.

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