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RISK MANAGEMENT OF CARDIOVASCULAR DISEASES DEVELOPMENT IN MINING COMPANY OPERATORS

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Risk Management of Cardiovascular Diseases Development in Mining Company Operators

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ABSTRACT

With a growing concern with the social aspects involved in the production, occupational health and safety has become extremely relevant. Thus, this work aims to develop a model to assist the cardiovascular risk management applicable to a team of off-road truck operators, who work in rotation shifts at a mining company from Brazil. For this, 191 workers were followed up in three periods (2010, 2012 and 2015) in this longitudinal study. The risk factors for cardiovascular disease among these workers were analyzed. Also, the risk of developing cardiovascular disease was calculated and the factors associated with it was identified through Qui-Square test, U Mann-Whitney test, and binary logistic regression. Lastly, preventive actions were suggested, which include advice, worker participation, and support from the company and leadership. In this sense, interventions of greater intensity are necessary to reduce alcohol intake and the levels of blood pressure and waist-to-height ratio. Prevalence of metabolic syndrome, high blood glucose and Low-Density Lipoproteins Cholesterol (LDL-C) levels should also be reduced, in addition to increasing High-Density Lipoproteins Cholesterol (HDL-C) levels in the entire population. Also, close monitoring of individuals over 38 years of age who smoke, consume alcoholic beverages and have altered blood glucose levels is important. Therefore, this study presents a model that helps decision making during risk management of cardiovascular disease development in an efficient way.

Keywords: Occupational Health and Safety, Risk Management, Cardiovascular Disease, Mining Workers

RESUMO

Com uma crescente preocupação com os aspectos sociais envolvidos na produção, a saúde e segurança ocupacional se tornaram extremamente relevantes. Assim, este trabalho tem como objetivo desenvolver um modelo para auxiliar o gerenciamento de risco cardiovascular aplicável a uma equipe de operadores de caminhões fora-de-estrada, que trabalham em turnos alternados em uma empresa de mineração do Brasil. Para isso, 191 trabalhadores foram acompanhados em três períodos (2010, 2012 e 2015) neste estudo longitudinal. Os fatores de risco para doença cardiovascular entre esses trabalhadores foram analisados. Adicionalmente, o risco de desenvolver doença cardiovascular foi calculado e os fatores associados a ele foram identificados através do teste de Qui-Quadrado, teste de U Mann-Whitney e regressão logística binária. Por fim, foram sugeridas ações preventivas, que incluem aconselhamento, participação dos trabalhadores e apoio da empresa e da liderança. Nesse sentido, são necessárias intervenções de maior intensidade para reduzir a ingestão de álcool e os níveis de pressão arterial e relação cintura-estatura. A prevalência de síndrome metabólica, glicemia alta e níveis de colesterol das lipoproteínas de baixa densidade (LDL-C) também deve ser reduzida, além de aumentar os níveis de colesterol das lipoproteínas de alta densidade (HDL-C) em toda a população. Além disso, é importante monitorar de perto os indivíduos com mais de 38 anos que fumam, consomem bebidas alcoólicas e apresentam níveis alterados de glicose no sangue. Portanto, este estudo apresenta um modelo que auxilia na tomada de decisão de forma eficiente durante o gerenciamento de riscos do desenvolvimento de doenças cardiovasculares.

Palavras-chave: Saúde e segurança ocupacional; Gerenciamento de riscos; Doenças cardiovasculares; Trabalhadores de mineração.

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LIST OF ABBREVIATIONS

AUDIT: Alcohol Use Disorders Identification Test

BF: Body Fat

BG: Blood Glucose (GS: Glicose Sanguínea)

BMI: Body Mass Index

BP: Blood Pressure (PA: Pressão Arterial)

CVDs: Cardiovascular Diseases (DCVs: Doenças Cardiovasculares)

DBP: Diastolic Blood Pressure

FBG: Fasting Blood Glucose

GDP: Gross Domestic Product

HDL-C: High Lipoproteins Cholesterol (Colesterol de Lipoproteína de Alta Densidade)

IBGE: Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística)

IBRAM: Brazilian Mining Institute (Instituto Brasileiro de Mineração)

IDF: International Diabetes Federation

ISO: International Organization for Standardization

LDL-C: Low Lipoproteins Cholesterol (Colesterol de Lipoproteína de Baixa Densidade)

MS: Metabolic Syndrome (SM: Síndrome Metabólica)

OHS: Occupational Health and Safety (SSO: Saúde e Segurança Ocupacional)

OR: Odds Ratio

SBC: Brazilian Cardiology Society (Sociedade Brasileira de Cardiologia)

SBP: Systolic Blood Pressure (PAS: Pressão Arterial Sistólica)

SD: Standard Deviation

SOCERJ: Cardiology Society of the State of Rio de Janeiro (Sociedade de Cardiologia do Estado do Rio de Janeiro)

TC: Total Cholesterol

TG: Triglycerides

WC: Waist Circumference (PC: Perímetro da Cintura)

WHO: World Health Organization (Organização Mundial da Saúde)

WHR: Waist-to-Height Ratio (RCE: Razão Cintura-Estatura)

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1. INTRODUCTION

According to the World Health Organization (WHO) (2017), cardiovascular diseases (CVDs) is the leading cause of death worldwide, with more than three-quarters of deaths occurring in low- and middle-income countries. Many CVDs may be prevented by changing habits such as smoking and diet (LEE et al., 2017). Besides, the control of known risk factors is effective in preventing the incidence of this disease (TSUTSUMI, 2015). Therefore, Schnall, Dobson and Landsbergis (2016) defend that a framework for primary prevention, including workplace transformation, may reduce conditions that contribute directly or indirectly to CVDs. For this, efficient risk management is important in order to identify the CVDs risk factors among workers and to take preventive actions.

Risk management is a proactive formal approach that efficiently organizes information about an unwanted event to support decision-making (POPLIN et al., 2015). According to Santos and de Oliveira (2019), risk management involves a careful documentation, evaluation, and decision-making process and is based on coordinated activities to help a company deal with risks. In this sense, Gül and Ak (2018) affirm that effective risk management requires a cycle of systematic practices that includes steps such as risk identification, assessment, control, and review. Thus, the way risks are understood and described strongly influences the way they will be analyzed and it may have serious implications for decision-making (AVEN, 2016).

Mining industries have a significant impact on the economy of Brazil. The mining extractive industries exported about US$ 29.9 billion and were responsible for generating one hundred eighty thousand direct jobs and two million indirect jobs in 2018 (IBRAM, 2019). In addition, the participation of extractive activities in the country total Gross Domestic Product (GDP), in 2019, corresponds to approximately 2.6%, and about 14.4% in the industrial GDP of the country in the same period (IBGE, 2019).

In particular, Occupational Health and Safety (OHS) in companies operating in hazardous sectors, such as mining, are vital and therefore, OHS management should be implemented according to their specific risks and requirements (İNAN; GÜL; YILMAZ, 2017). Mining employees may be exposed to several factors that may increase their risk of non-communicable diseases (RODRIGUEZ-FERNANDEZ et al., 2015), including risks of CVDs. In this regard, Zhou et al. (2018) defend that mining companies need to emphasize OHS management, due to their environment with complicated operating conditions and various risk factors. Therefore, given the relevance to the national economy and the risks present in the mining sector, further studies covering the prevention of worker health in this sector are needed.

1.1. OBJECTIVES

OHS is an increasingly complex problem that involves many fields and is attracting wide attention from many scholars (CHEN et al., 2020). A recent literature review, performed by da Silva and Amaral (2019), pointed out that OHS management studies emphasize work safety issues more than workers' health issues and that more effective OHS epidemiological management is lacking. Therefore, the main goal of the present work is to develop a model to assist the CVDs risk management. This model will be applicable to a team of off-road truck operators that works in shifts at a mining company located in Minas Gerais. Then it will be possible to identify and prevent the main factors responsible for CVDs in this population. For this, a longitudinal study was carried out.

The specific objectives are:

- Researching health protocols that indicate the limit values for CVDs risk factors.
- Analyzing the risk factors for CVDs of 191 operators during follow-up.
- Calculating the cardiovascular risk of operators during follow-up.
- Identifying the factors associated with a higher risk of developing CVDs.
- Evaluating if these factors are associated with some specific group.
- Suggesting and discussing actions to prevent CVDs.

This study may also bring an important contribution to public health. That is because some studies have already indicated that complications due to the new coronavirus (COVID-19) are related to CVDs and some of its risk factors, such as hypertension, diabetes (WANG et al., 2020; ZHENG et al., 2020), smoking (ZHENG et al., 2020) and obesity (KASSIR, 2020). In this sense, the present study, besides seeking the prevention of CVDs, may also reduce the risk of aggravation due to COVID-19 in this population.

2. THEORETICAL FOUNDATION

2.1. RISK MANAGEMENT AND ISO 31000

Risks are ubiquitous in most human activities and are a topic of study in both human and applied science (TCHIEHE; GAUTHIER, 2017). In most cases, risks are assessed in terms of likelihood of occurrence and their impact (BADRI, 2015). The risk management includes processes that may prevent problems or unwanted results. In addition, the risk management process must be continuously improved and requires constant monitoring in order to identify possible changes in relation to risks.

In this sense, risk management is a proactive formal approach that may be used to improve workplace safety and health (POLLACK et al., 2017). However, OHS risk management has some difficulties, such as the lack of applicability of some regulations, lack of resources and trained OHS personnel in companies (SANTOS; DE OLIVEIRA, 2019). In addition, Sousa, Almeida and Dias (2014) defend that risk management, especially when applied to OHS, can be subjective due to factors such as the type of risk, the level of knowledge or information, the individual, social and cultural contexts, among others.

In this context, the International Organization for Standardization (ISO) 31000 is the current standard that support the risk management process. Moreover, it has become a generic and recognized standard, which provides risk management principles and guidelines (BARAFORT; MESQUIDA; MAS, 2017). It enables the management of any risk in a systematic, transparent and reliable way (DE OLIVEIRA et al., 2017b). Lastly, this standard is not for certification purposes, in this sense, according to Barafort, Mesquida and Mas (2017) it may allow the implementation of a management system in a non-prescriptive manner.

According to Roberts (2015), the risk management principles of ISO 31000 are fundamental to occupational health and safety management systems and present a systematic methodology for identifying, analyzing, and control the risks. In addition, they may form a foundation on which there is an increase in collective competences and the best practices may be shared (OLECHOWSKI et al., 2016). The ISO 31000:2018 also outlines the steps for the risk management process. These steps are discussed below.

- Communication and consultation: It has the objective of allowing access to information and allowing stakeholders to understand risks and make decisions.
- Scope, context, and criteria: At this stage, risk management is customized. Therefore, it is necessary to establish the context in which it will be applied, to define the objectives and risk acceptance criteria.
- Risk Assessment: At that moment, risks are identified and analyzed, often in relation to the probability of occurrence, sources of the risk and consequences. The data found in this stage are evaluated according to the acceptance criteria

- Risk Treatment: At this stage, actions are selected and implemented to achieve the risks. Thus, it is possible to avoid the risk, remove the source, change the probability, change the consequences, and share the risks, among others.
- Recording and reporting: The risk management process as well as its outcomes are documented to improve the process, provide useful decision-making information, and support the communication with stakeholders.
- Monitoring and review: These activities should take place at all stages of risk to ensure and improve process effectiveness.

Among these steps, Santos and de Oliveira (2019) defend that the risk assessment is considered critical as it involves the steps of risk identification and consideration of the sources of risk that may affect the objectives of an organization. In addition, this phase provides decision support in choosing between alternatives and implementing risk mitigation measures (AVEN, 2016). However, within the context of the OHS, the criteria setting stage also presents some difficulties, as risks may have consequences for human life. Tchiehe and Gauthier (2017) identified, through a literature review, some parameters (like cultural, social, psychological, ethical, among others) that may influence the acceptability or tolerability of OHS risks, suggesting that the decision to accept a risk in OHS is subjective.

It is also worth mentioning the role of legislation in the management of OHS risks. According to Chen et al. (2020), the law has a dissuasive role in this regard and can generate positive effects on OHS, through incentive mechanisms and the establishment of fines or taxes. In Brazil, among the many labor laws, there are also norms to protect the health and safety of all workers in various occupational areas (DE OLIVEIRA et al., 2017a). In this sense, a country’s legislation can influence the level of acceptance of a particular risk.

2.2. OCCUPATIONAL HEALTH AND SAFETY

Every year a large number of workers die, are injured, or become ill due to occupational risks(MOATARI-KAZEROUNI; CHINNIAH; AGARD, 2015). According to Ozturkoglu, Kazancoglu and Ozkan-Ozen (2019), through systematic OHS management companies may optimize preventive actions in order to improve OHS performance and create organizational benefits. Because of this, OHS is an important factor for the well-being of modern society and it has received increasing attention from the scientific community (PAPAZOGLOU et al., 2017).

A study by Luthra et al. (2017) identified that the health and safety system is considered the most important criterion in the social dimension of sustainability and it is among the top five criteria for selecting sustainable suppliers in the supply chain. Thus, it is possible to notice that recently there is a paradigm shift in progress regarding the protection and promotion of workers' health (SORENSEN et al., 2016), increasing the importance and concern with occupational health. In this sense, an appropriate OHS management system may positively affect a company's image, thereby improving its competitiveness.

With rising health costs, many companies have been looking for employee health programs to reduce disease burden, productivity losses, and high disease management costs (ANENI et al., 2014). Sousa, Almeida and Dias (2015) argue that some costs of occupational accidents or illness may be the loss of income and additional expenses for workers, administrative costs, fines and recruitment expenses for companies, and an increase in expenses with health services and social security for society. According to de Weerd et al. (2014) costs arising from occupational injuries and illnesses are classified into five main types (productivity costs, healthcare costs, loss of quality of life, administration costs and insurance costs) and are assessed in terms of costs for four stakeholders (workers and family, employers, government and society).

Thus, it is possible to realize that accidents and occupational diseases generate various economic costs that affect several members of a society. In this sense, OHS management seeks to improve workplace health and safety by reducing costs that may be caused by inadequate work environment, insufficient information, and low employee awareness or lack of attention (İNAN; GÜL; YILMAZ, 2017).

The conditions of work are associated with OHS results and may be responsible for certain chronic diseases (SORENSEN et al., 2016). Some of occupational factors related with OHS results are: Leadership support (SKŁAD, 2019; DIETZ et al., 2020), internal policies and actions aimed at promoting a positive work environment and health (READER et al., 2017; SPARER et al., 2018) and the involvement of workers (SORENSEN et al., 2016; HASSAM et al., 2018), through participatory interventions (VON THIELE SCHWARZ et al., 2017). Therefore, a preventive culture is needed, which encourages the participation and commitment of all hierarchical levels.

2.3.CARDIOVASCULAR DISEASES

In the context of occupational health, the prevalence and prevention of Cardiovascular Disease (CVDs) is a topic that deserves attention. According to WHO (2017), CVDs is a group of disorders of the heart and blood vessels. Inappropriate lifestyles, with the presence of factors such as physical inactivity, obesity and stress, cause an increase in factors such as high blood pressure, smoking, diabetes and dyslipidemia, thus increasing the prevalence of cardiovascular disease (PRÉCOMA et al., 2019). In this sense, it is possible to note that most risk factors for CVDs are modifiable.

A survey conducted by Yusuf et al. (2020) indicated that about 70 % of CVDs and deaths in high and low-income countries, including Brazil, were attributable to modifiable risk factors. Then, it is necessary to act preventively on these factors in order to reduce or eliminate them, and consequently reduce the risk of developing CVDs. It is also worth mentioning that in low and middle-income countries, factors such as socio-economic inequality and culture affect the development of risk factors and in the access that individuals will have to care (MODESTI et al., 2014).

CVDs results in costs and impacts on society due to factors such as treatment expenses, loss of productivity at work, costs of providing assistance and loss of well-being (STEVENS et al., 2018). According to a survey conducted by Siqueira, de Siqueira-Filho and Land (2017), the direct and indirect costs of CVDs in Brazil increased between 2010 and 2015 and it is estimated that these costs will increase with the aging of the population and with the increasing prevalence of this disease. In addition, the CVDs risk factors themselves are related to absenteeism, which also brings costs to the company, such as smoking (RABACOW et al., 2014), overweight and obesity (KUDEL et al., 2018).

The aging of the working population and lifestyle factors increase the risk of CVDs and are often in complex interaction with work factors (TSUTSUMI, 2015). In this sense, psychosocial factors at work and healthy behaviors play an important role in the development of CVDs (CHEN et al., 2018). Therefore, there is a growing interest among researchers in understanding, which factors in the workplace may contribute to a higher risk of developing CVDs.

Interventions at the worksite may be a good way to reduce the risks of populations (ELSHATARAT; BURGEL, 2016). Many studies have identified that several occupational factors may be associated with CVDs such as long working hours (KIVIMÄKI; KAWACHI, 2015; CHEN et al., 2018) as well as working excessively and compulsively (SALANOVA et al., 2016), high work stress (KIVIMÄKI; KAWACHI, 2015; CHEN et al., 2018) and shift work (TORQUATI et al., 2018; WANG et al., 2018). In addition, a study by Souza et al. (2015) showed associations between shift work and some cardiovascular risk factors such as cardiac regulation and blood pressure. The occupational factors identified by these studies are present in the mining sector. Therefore, special attention to occupational health and prevention of the development of CVDs in mining is required.

The treatment of many individuals is focused on a single CVDs risk factor or in the prevalence of the risk factors. However, this approach does not provide adequate knowledge about the risk of future cardiovascular effects (BABATUNDE et al., 2020). In this sense, the identification of individuals who have a high general risk of CVDs is important, as it allows for more efficient prevention and control. Modesti et al. (2014) defend that the identification of individuals who have a high risk of CVDs may help in decision-making and avoid unnecessary expenses in the treatment of individuals with low risk.

The estimation of cardiovascular risk, conducted through tools that calculate the probability of suffering a cardiovascular event over a period, is a key point to identify the best treatment for the patient (SACRAMENTO-PACHECO et al., 2019). Some risk scores have already been developed to calculate the overall risk of developing CVDs. The Framingham score is often used in primary health care to early detect individuals at risk for CVDs (ZWAARD et al., 2019). It may be calculated using some risk factors, including laboratory data, such as age, systolic blood pressure, smoking, diabetes, HDL, and total cholesterol. This score also presents an alternative calculation in which BMI can be used, in cases that it is not possible to collect cholesterol levels. According to Zwaard et al. (2019), a large number of individuals at risk for CVDs may be identified through the implementation of the non-laboratory Framingham score in occupational health researches. Therefore, this score may play a fundamental role in the prevention of CVDs in the company context.

3. METHODOLOGY

A longitudinal study was carried out in mining companies in the region of Inconfidentes, in Minas Gerais, Brazil, and was divided into three phases: 2010, 2012 and 2015. These years were chosen according to the budget availability of the project. The study population consists of 191 male off-road truck operators, who worked on rotation shifts, being all of them, followed during all the years of the study.

The working day of these individuals is six hours per shift, with a rest of twelve hours between shifts. The alternation of work and rest time for workers occurs on a rotating basis. The individual starts the rotation cycle working from 7:00 pm to 1:00 am and then from 1:00 pm to 7:00 pm and from 07:00 am to 1:00 pm, ending with work from 01:00 am to 07:00 am. The next day, the individual does not work, which characterizes the rest. Then, the individual returns to work the day after the break, from 7:00 pm to 1:00 am, restarting the cycle after thirty-six hours of rest.

Regarding data collection, this research project was submitted and approved by the Research Ethics Committee of the Federal University of Ouro Preto (UFOP) (CAAE: 0018.0.238.000-11 and CAAE: 39682014.7.0000.5150), under the opinion number 1.381.376, and all volunteers signed a free and informed consent form.

First, the interviewers underwent training on the instruments of data collection, the procedure that should be adopted by them during the interviews, and the collection techniques. They then applied the questionnaires and performed the measurements and gauging on healthy volunteers to standardize the procedures. Before the fieldwork in the mines, a pilot test was performed with all the instruments to be used during the research. Therefore, it was possible to evaluate the feasibility and applicability of data collection instruments for the population and the place of study.

Initially, workers on rotation shift regime were approached by the research professors, who explained the study, voluntary participation, and data confidentiality. The individuals who agreed to participate signed the informed consent form, after which the team, properly trained, began to collect the data.

3.1. VARIABLES

The socio-demographic and behavioral variables of education (classified as incomplete and complete 1st degree; incomplete and complete 2nd degree; technical level; and incomplete; and complete higher education), marital status (married; not married; and separated), age (classified according to the median in each year), race (white; yellow; black; and brown) and time in shift work (less than 5 years of shift work; 5 or more years of shift work) were collected through questionnaires. The smoking variable was collected through the Fagerström Tolerance Questionnaire and it was classified as ‘No’ (individuals who do not smoke); and ‘Yes’ (for smokers, regardless of frequency) (Brazilian Society of Pulmonology and Tisiology [SBPT], 2011). The Alcohol Use Disorders Identification Test (AUDIT) was used for the alcohol intake variable, that was classified as 'No' (individuals who do not drink); and 'Yes' (for those who drink, regardless of quantity or frequency) (Babor et al., 2001). Anthropometric measurements of height and weight were collected with workers standing and wearing light clothing. Waist Circumference (WC) was measured in duplicate at the midpoint between the iliac crest and the last costal arch. In addition, Body Mass Index (BMI) and Waist-to-Height Ratio (WHR) were analyzed. BMI was calculated by dividing the weight measurement by the square of the height measurement. The WHR was calculated by dividing the WC measurement by the height measurement.

The body composition variable was assessed through the percentage of Body Fat (BF), which was estimated using a portable tetrapolar electric bioimpedance monitor. The clinical variable of Blood Pressure (BP) was measured with the subject seated after resting for approximately 5 minutes in a calm environment, in triplicate, with a minimum interval of 3 minutes between measurements, using a MICROLIFE R digital semiautomatic device.

For biochemical variables, after fasting for 12 hours, workers were subjected to the collection of 14 mL of venous blood by vacuum puncture of the cubital vein in two tubes, one with sodium fluoride to measure serum glucose and the other without anticoagulant for the determination of total cholesterol and fractions. The samples were collected for analysis of Blood Glucose (BG), Triglycerides (TG) and Total Cholesterol (TC) and fractions.

3.2. CLASSIFICATION OF RISK FACTORS

The variables analyzed in this work were classified according to Table 1, which also presents the references used. For the classification of individuals with metabolic syndrome, the definition proposed by the International Diabetes Federation (IDF) (2006) was used. In this sense, individuals with metabolic syndrome (MS) are those who present abdominal obesity ($WC \geq 90$ cm for the population studied) plus two of the following four factors: increased triglyceride level (≥ 150 mg/dL or specific treatment for this lipid abnormality), reduced HDL-C (< 40 mg/dL in men or treatment), high blood pressure [(Systolic Blood Pressure (SBP) ≥ 130 mmHg or Diastolic Blood Pressure (DBP) ≥ 85 mmHg or treatment of previously diagnosed hypertension] and increased Fasting Blood Glucose ($FBG \geq 100$ mg/dL or type 2 diabetes previously diagnosed).

Table 1: Risk factors classification

Classification		References
BMI (*kg/m²*)		(WHO, [s.d.])
< 18.5	Underweight	
18.5 - 24.9	Normal weight	
25.0 - 29.9	Overweight	
≥ 30.0	Obese	
BF* (%)		(US DEPARTMENT OF HEALTH AND HUMAN SERVICES, 2008)
> 25.0	Obese	
WC (cm)**		(IDF, 2006)
≥ 90.0	Central Obesity	
WHR*		(SOCIEDADE DE CARDIOLOGIA DO ESTADO DO RIO DE JANEIRO (SOCERJ), 2017)
< 0.51	Good/Great	
0.51 − 0.57	Regular	
≥ 0.57	Bad	
BP (mmHg)		(IDF, 2006)
≥ 130(*systolic*)/85(*diastolic*)	Raised Blood Pressure	
TC (mg/dL)		(FALUDI et al., 2017)
< 190	Desirable	
HDL-C (mg/dL)		(FALUDI et al., 2017)
> 40	Desirable	
LDL-C (mg/dL)		((FALUDI et al., 2017)
≥ 160	Raised LDL-C	
TG (mg/dL)		(FALUDI et al., 2017)
< 150	Desirable	
BG (mg/dL)		(IDF, 2006)
≥ 100	Raised fasting plasma glucose	

*Notes: * Males; ** South and Central Americans Males. BMI - Body Mass Index; BF - Body Fat; WC - Waist Circumference; WHR - Waist-to-Height Ratio; BP - Blood Pressure; TC - Total Cholesterol; HDL-C - High Density Lipoproteins; LDL-C - Low Density Lipoproteins; TG - Triglycerides; BG - Blood Glucose*

Source: Author

For the estimate of the risk of developing CVDs in 10 years, the score presented by the V guidelines for dyslipidemia and prevention of atherosclerosis of Brazilian Cardiology Society (SBC) (XAVIER et al., 2013) was used. This score is also suggested by the I Brazilian guidelines for cardiovascular prevention (SIMÃO et al., 2013) and its update (PRÉCOMA et al., 2019). The risk calculation is based on the individual’s age, Systolic Blood Pressure (SBP), HDL and total cholesterol levels, smoking and the presence of diabetes [BG values ≥ 126 mg/dL according to WHO (2016)]. After the sum of these factors, scores are established and they are subsequently classified as low risk (< 5%), moderate (≥ 5% and ≤ 20%), and high risk (> 20%) of developing CVDs in 10 years.

3.3. DATA ANALYSIS

The risk management steps proposed by ISO 31000 (2018) were used as a basis and adapted to the context of occupational health and objectives of this work. IBM SPSS Statistics, Minitab 17 and R were used for data analysis. The normality of the data was verified by the Anderson-Darling test and the Pearson's Test verified the correlation between the variables. The Wilcoxon test was used for longitudinal analyses. In addition, to analyze the association between variables and cardiovascular risk, the Chi-Square, U Mann-Whitney tests and binary logistic regression were used. Finally, the Chi-Square and U Mann Whitney tests were also used to verify the association between risk factors and age. For all tests used, the significance level considered was 0.05. In this sense, the following steps were taken to build the model to aid cardiovascular risk management.

3.3.1. Context Establishment

To identify the context of these individuals, descriptive analysis of socio-demographic variables will be presented. The prevalence of risk factors in the population has been identified. In addition, the evolution of risk factors for CVDs among workers in the period from 2010 to 2015 was analyzed, through the Wilcoxon test. This test is less sensitive to non-normal variables than parametric tests like T-paired. Therefore, it was chosen due to the lack of normality in some variables. With this step, it was possible to identify the context of workers health and if there were significant changes during the follow-up period.

3.3.2. Risk Assessment

In the second stage, the cardiovascular risk was analyzed. For this, descriptive analysis of the individuals' risk in the follow-up will be presented, through quartiles, boxplot and profile graph of the scores and prevalence in each risk classification. The risk variation between 2010 and 2015 will be analyzed using Wilcoxon test. In addition, some steps was taken in order to evaluate which factors are significantly associated with an increased risk of developing CVDs and whether some interventions should have greater monitoring in a particular group of individuals.

- **1st step**: U Mann Whitney and Chi-Square tests were performed to assess whether there is a difference in risk factors in relation to each classification, then identifying which of them may be related to risk levels. The relationship between the time that individuals work in rotation shifts and risk ratings will also be analyzed using the U Mann Whitney test. This test was also chosen due to the lack of normality in some variables.

- **2nd step:** A univariate binary logistic regression model was performed for each risk factor in order to identify those who may be significant predictors of a more serious risk category. Also, a multivariate binary logistic regression model was adjusted for age, alcohol intake and smoking.
- **3rd step:** Finally, U Mann Whitney and Chi-Square tests were performed to identify the association between the individuals' age and the risk factors that were significant in steps 1 or 2. For this, workers was separated into two groups according to the median age.
- **4th step:** Finally, the model will be developed based on the prevalence of risk factors, accessed in the context establishment step, and on the factors associated with cardiovascular risk and age.

3.3.3. Risk treatment

In the third and final stage, some suggestions will be discussed to preventively reduce the risk of developing CVDs. These suggestions will be based on the main factors associated with the highest levels of risk.

4. RESULTS

4.1. CONTEXT ESTABLISHMENT

The population studied consists of 191 males off-road truck operators who work on a rotation shift regime. The team is composed mainly of married individuals (76.4 %), who has been working on shifts for more than five years (77.0%), with complete high school (59.2 %) and with technical level (24.6 %). Also, the majority of operators are white (35.6 %), brown (34.6 %), and black (24.1 %). The mean age of respondents on the baseline was 34.27± 6.94 years.

Table 2 shows the descriptive analysis of the risk factors for CVDs in 2010, 2012 and 2015. In addition, it identifies whether there are significant variations during the studied period, comparing the results in 2010 and 2015. It is possible to notice that the level of LDL-C decreased between 2010 and 2015, which is a significant reduction. The others risk factors increased in the period 2010 to 2015. However, the increase in the level of BF and BG was not significant.

Table 2: Descriptive analysis of risk factors and Wilcoxon test

	2010	2012	2015	P-value
	Mean (SD); median	Mean (SD); median	Mean (SD); median	2010-2015
Weight *(kg)*	81.4 (12.8); 81.2	81.1(12.5); 80.7	83.0 (12.8); 82.8	<0.001*
BMI *(kg/m^2)*	26.8 (3.8); 26.5	26.5 (3.6); 26.2	27.2 (3.6); 27.1	<0.001*
BF (%)	22.3 (5.7); 22.8	25.2 (10.3); 23.1	22.6 (5.4); 22.7	0.621
WC (*cm*)	91.6 (10.7); 91.8	91.5 (9.4); 91.1	94.5 (9.3); 94.1	0.008*
WHR	0.53 (0.06); 0.53	0.52 (0.05); 0.52	0.54 (0.05); 0.54	<0.001*
SBP (*mmHg*)	128.9 (16.0); 129.7	132.2 (12.3); 131.7	135.1 (13.3); 135.0	0.001*
DBP (*mmHg*)	79.6 (9.8); 79.0	82.8 (8.4); 82.0	84.6 (9.1); 84.5	<0.001*
TC (*mg/dL*)	196.1 (43.3); 188.8	193.6 (41.2); 189.0	207.7 (41.0); 201.8	<0.001*
HDL-C (*mg/dL*)	43.1 (10.8); 44.0	56.2 (15.2); 56.1	52.7 (11.1); 52.2	0.028*
LDL-C (*mg/dL*)	125.3 (40.5); 117.8	107.5 (35.0); 105.5	117.0 (34.2); 115.4	0.001*
TG (*mg/dL*)	138.6 (66.2); 123.3	149.6 (69.5); 139.0	196.5 (96.9); 172.8	<0.001*
BG (*mg/dL*)	90.3 (10.6); 89.0	88,0 (13.2); 85.0	90.6 (12.1); 89.4	0.901

*Notes: * p < 0.05 was considered statistically significant. BMI - Body Mass Index; BF - Body Fat; WC - Waist Circumference; WHR - Waist-to-Height Ratio; SBP - Systolic Blood Pressure; DBP - Diastolic Blood Pressure ; TC - Total Cholesterol; HDL-C - High Density Lipoproteins Cholesterol; LDL-C Low Density Lipoproteins Cholesterol; TG - Triglycerides; BG - Blood Glucose.*

Source: Author

Table 3 shows the prevalence of the risk factors in 2010, 2012 and 2015. Comparing the prevalence of risk factors in 2010 and 2015, is possible to notice that there was a reduction of 8.5% in the prevalence of alcohol consumption and a reduction of 22.9% of smokers in the studied period. There was an increase of 6.5% of overweight individuals and 11.1% of operators with obesity. Considering the percentage of BF, the increase of obese individuals was 13.8% during the follow-up period. In addition, the proportion of individuals with central obesity increased by 30.2%, while the prevalence of individuals with regular WHR increased by 12.3% and with bad WHR increased by 35.0%. Regarding BP, there was an increase of 33.3% of workers with raised BP. In 2010, there was a percentage of 27.8% of individuals with MS. During the studied period, this prevalence increased by 43.4%, reaching a percentage of 39.8% of individuals with MS in 2015.

It is possible to note that the prevalence of individuals with TC above 190 mg/dL increased by 30.8% and the number of individuals with TG above 150 mg/dL increased by 88.7% between 2010 and 2015. However, there is a reduction of 71.2% in the prevalence of HDL-C levels below 40 mg/dL and a reduction of 46.0% in individuals with LDL-C greater than or equal to 160 mg/dL during the studied period. Finally, BG levels also improved in the population studied, with a 39.4% reduction in the prevalence of levels above 100 mg/dL. For the variation between 2010 and 2012 and between 2012 and 2015, see Table 3.

Table 3: Prevalence of risk factors in the period studied

	2010 N (%)	2012 N (%)	2015 N (%)	% Variation (2010-2012)	% Variation (2012-2015)	% Variation (2010-2015)
Alcohol intake						
No	50 (26)	60 (31)	62 (32)	20	3	24
Yes	141 (74)	131 (69)	129 (68)	-7	-2	-8
Smoking						
No	156 (82)	161 (84)	164 (86)	3	2	5
Yes	35 (18)	30 (16)	27 (14)	-14	-10	-23
BMI						
Underweight	2 (1.1)	1 (0.5)	0 (0.0)	-50	[a]	[a]
Normal	61 (31.9)	67 (35.1)	53 (27.8)	10	-21	-13
Overweight	92 (48.2)	91 (47.6)	98 (51.3)	-1	8	6
Obese	36 (18.9)	32 (16.8)	40 (20.9)	-11	25	11
BF						
Normal	132 (70)	114 (60)	123 (65)	-14	8	-7
Obese	58 (30)	75 (40)	66 (35)	29	-12	14
WC						
Normal	85 (44)	82 (43)	53 (28)	-4	-35	-38
Central obesity	106 (56)	109 (57)	138 (72)	3	27	30
WHR						
Good	78 (41)	86 (45)	55 (29)	10	-36	-30
Regular	73 (38)	68 (36)	82 (43)	-7	21	12
Bad	40 (21)	37 (19)	54 (28)	-7	46	35
BP						
Normal	92 (48)	80 (42)	59 (31)	-13	-26	-36
Raised BP	99 (52)	111 (58)	132 (69)	12	19	33
MS						
No	138 (72)	133 (70)	115 (60)	-4	-14	-17
Yes	53 (28)	58 (30)	76 (40)	9	31	43
TC						
< 190 mg/dL	97 (51)	98 (51)	68 (36)	1	-31	-30
≥ 190 mg/dL	94 (49)	93 (49)	123 (64)	-1	32	31
HDL-C						
> 40 mg/dL	118 (62)	162 (85)	170 (89)	37	5	44
≤ 40 mg/dL	73 (38)	29 (15)	21 (11)	-60	-28	-71
LDL-C						
< 160 mg/dL	154 (81)	173 (91)	163 (89)	12	-2	6
≥ 160mg/dL	37 (19)	18 (9)	20 (11)	-51	16	-46
TG						
< 150 mg/dL	129 (68)	105 (55)	74 (39)	-19	-30	-43
≥ 150 mg/dL	62 (32)	86 (45)	117 (61)	39	36	89
BG						
< 100 mg/dL	158 (83)	170 (91)	171 (90)	10	-2	8
≥ 100 mg/dL	33 (17)	17 (9)	20 (10)	-47	15	-39

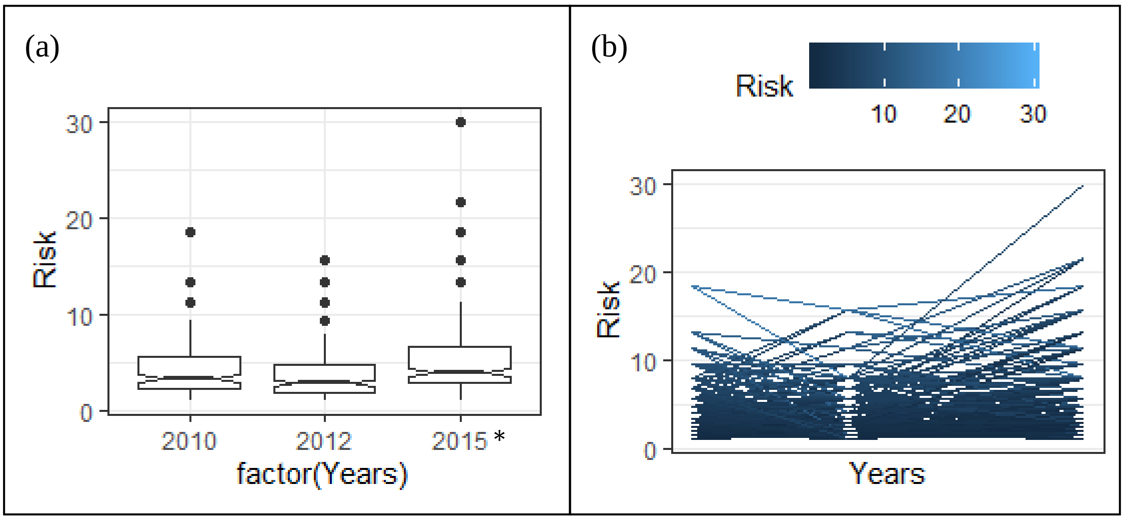
Notes: ! In 2015 there were no individuals classified as underweight. BMI - Body Mass Index; BF - Body Fat; WC - Waist Circumference; WHR - Waist-to-Height Ratio; BP - Blood Pressure; MS - Metabolic Syndrome; TC - Total cholesterol; HDL-C - High Density Lipoproteins Cholesterol; LDL-C - Low Density Lipoproteins Cholesterol; TG - Triglycerides; BG - Blood Glucose.

Source: Author

4.2. RISK ASSESSMENT

The risk of developing CVDs within a 10-year period was calculated according to the methodology indicated by SBC. Figure 1(a) shows the evolution of the risk of developing CVDs through the boxplot, and Figure 1(b) shows this evolution through a profile graph. Figure 2 presents the histogram of the risk during the follow-up time. In 2010 the risk ranged between 1% and 18.4%; however, in 2015 this variation was from 1.1% to 30%. In addition, it is possible to note that the third quartile in 2010 was 5.6% and in 2015 it was equivalent to 6.7%. Thus, it is possible to notice a significant increase of the risk during the follow-up ($p < 0.001$). When analyzing who are the individuals in the third quartile, and if they are the same in 2010 and 2015, it is possible to observe that 37% of the individuals in this quartile in 2015 did not belong to this risk group in 2010. Moreover, among the individuals who have already belonged to that quartile in 2010, 74% had an increase in the risk. Therefore, we see that the individuals are acquiring risk factors for the CVDs development.

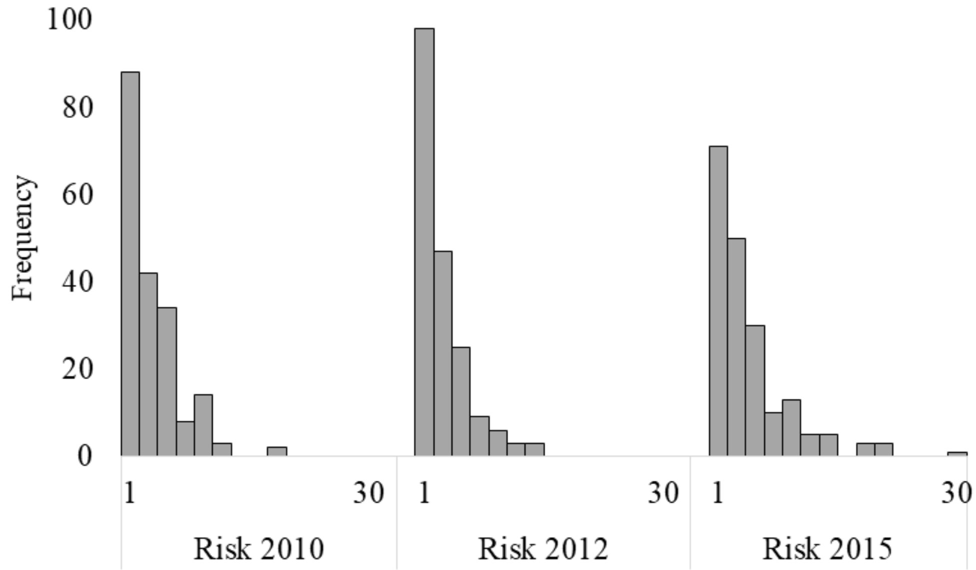
Figure 1(a): Boxplot of risk of developing CVDs; Figure 1(b): Profile graph of cardiovascular risk



*Notes: * Significant increase from 2010 to 2015 according to the Wilcoxon Test (p-value < 0.001).*

Source: Author

Figure 2: Histogram of the risk during the follow-up



Source: Author

Regarding risk categories, there was an upward trend of moderate risk and high risk. In 2010, 31.9% of individuals were at moderate risk and none was classified as high risk. In 2015, the prevalence of individuals with moderate risk was equivalent to 34.6% and the number of individuals with high risk was equal to 2.1%, being a warning point. Meanwhile, the prevalence of low-risk dropped from 68.1% in 2010 to 63.3% in 2015.

Due to the growth in the moderate and high risks in 2015, the possible factors associated with these categories at the end of the follow-up were evaluated. For this, the individuals from these two classifications were gathered in the same group: Moderate/High. Table 4 shows that there is a significant difference between the risk classifications in the factors of Age, WHR, SBP, BG, HDL-C and LDL-C. There was also a significant difference in the prevalence of smoking, alcohol intake and MS. For the other factors, including the time that the individual works on a shift regime, there was no significant difference between the risk classifications.

Table 4: Factors stratified by CVDs development risk classifications in 2015

	Low risk (N=121)	Moderate / High (N=70)	P-value
Age (years)	35.0 (32.0 - 37.0)	44.0 (40.0 - 51.0)	<0.001*
Time in shift work (years)	10.8 (9.0 - 15.0)	11.2 (9.0 - 15.0)	0.836
Weight (kg)	83.0 (74.5 - 91.5)	81.7 (74.0 - 87.8)	0.438
BMI (*kg/m*^{2})	26.8 (24.3 - 29.4)	27.3 (25.6 - 29.5)	0.192
BF (%)	22.9 (19.9 - 26.1)	22.3 (19.1 - 27.0)	0.968
WC (cm)	93.5 (88.4 - 99.2)	95.3 (89.7 - 101.0)	0.272
WHR	0.53 (0.50 - 0.57)	0.55 (0.52 - 0.59)	0.014*
SBP (mmHg)	132.0 (123.5 - 141.5)	136.5 (130.0 - 145.0)	0.019*
DBP (mmHg)	84.0 (76.0 - 90.5)	86.5 (81.0 - 92.5)	0.087
TC (mg/dL)	196.4 (179.1 - 226.5)	211.1 (184.5 - 239.2)	0.093
HDL-C (mg/dL)	53.9 (45.6 - 60.6)	49.5 (43.4 - 58.5)	0.017*
LDL-C (mg/dL)	109.8 (89.1 - 130.5)	128.0 (100.1 - 138.7)	0.009*
TG (mg/dL)	165.6 (119.1 - 257.9)	176.9 (136.6 - 235.1)	0.201
BG (mg/dL)	88.2 (83.1 - 92.7)	91.9 (85.4 - 97.3)	0.008*
MS (%)			0.028*
No	66.1	50.0	
Yes	33.9	50.0	
Alcohol intake (%)			0.031*
No	38.0	22.9	
Yes	62.0	77.1	
Smoking (%)			< 0.001*
No	96.7	67.1	
Yes	3.3	32.9	

*Notes: * p < 0.05 was considered statistically significant. Results expressed as median and interquartile range. BMI - Body Mass Index; BF - Body Fat; WC - Waist Circumference; WHR - Waist-to-Height Ratio; SBP - Systolic Blood Pressure; DBP - Diastolic Blood Pressure ; TC - Total Cholesterol; HDL-C High Density Lipoproteins Cholesterol; LDL-C - Low Density Lipoproteins Cholesterol; TG Triglycerides; BG - Blood Glucose; MS - Metabolic Syndrome.*

Source: Author

In addition, through binary logistic regression, a univariate analysis was carried out in order to identify the association of each factor with the risk of developing CVDs. Table 5 presents the results of this analysis. It is possible to verify that the variables Age ($p < 0.001$) and SBP ($p = 0.018$) presented a statistically significant relationship with the risk classification. The increase of 1 year in age increases the chance of the worker belonging to the moderate/high risk group by 47.0%. Whereas the increase of 1 mmHg in SBP increases the individual's chance of belonging to this group by 2.8%.

The HDL-C ($p = 0.026$), LDL-C ($p = 0.020$) and BG ($p = 0.006$) also have a significant association with cardiovascular risk. The 1 mg/dL increase in HDL-C reduces the chance of an individual being classified as moderate/high risk by 3.2 %. This same increase in LDL-C and BG increases the chance of the worker belonging to the moderate/high group by 1.1 % and 4.8%, respectively. This same significant relationship was found for the categorical variables MS ($p = 0.029$), alcohol intake ($p = 0.033$) and Smoking ($p < 0.001$). The presence of metabolic syndrome increases the chances of an individual having a higher risk by 95.1%. While alcohol intake and smoking increase this chance by 2 times and 14 times, respectively.

Table 5: Binary logistic regression - univariate analysis for 2015 data

	Odds ratio	95 % CI		p-value
Age	1.470	1.316	1.643	<0.001*
Time in shift work	1.001	0.997	1.004	0.684
Weight	0.994	0.971	1.017	0.620
BMI	1.052	0.970	1.142	0.220
BF	1.013	0.958	1.071	0.660
WC	1.018	0.986	1.051	0.273
SBP	1.028	1.005	1.052	0.018*
DBP	1.028	0.995	1.063	0.100
TC	1.005	0.998	1.013	0.148
HDL-C	0.968	0.940	0.996	0.026*
LDL-C	1.011	1.002	1.020	0.020*
TG	1.001	0.998	1.004	0.523
BG	1.048	1.014	1.083	0.006*
MS	1.951	1.070	3.559	0.029*
Alcohol intake	2.070	2.062	4.036	0.033*
Smoking	14.314	4.696	43.626	< 0.001*

*Notes: * p < 0.05 was considered statistically significant. Due to the nature of the data, the variable WHR was not considered. BMI - Body Mass Index; BF - Body Fat; WC - Waist Circumference; SBP - Systolic Blood Pressure; DBP - Diastolic Blood Pressure ; TC - Total Cholesterol; HDL-C - High Density Lipoproteins cholesterol; LDL-C - Low Density Lipoproteins Cholesterol; TG - Triglycerides; BG Blood Glucose; MS - Metabolic Syndrome.*

Source: Author

A multivariate binary logistic regression was adjusted, using the significant risk factors. Through Table 6, it is possible to note that, after adjusting for age, alcohol intake and smoking, the variables SBP, HDL-C and LDL-C still have significant association with cardiovascular risk. The increase of 1 mmHg in SBP increases by 14.6% the individual's chance to belong to Moderate/High risk. Also, the increase of 1 mg/dL in HDL-C reduces the chance of an individual being classified as moderate/high risk by 15.8%. This same increase in LDL-C raises by 5.1% the change of the worker belonging to this group.

Table 6: Binary logistic regression - multivariate analysis for 2015 data

Risk factors	β	Standard Error	Odds ratio	95% Confidence interval	P-value
SBP	0.136	0.041	1.146	(1.058; 1.241)	0.001*
HDL-C	-0.172	0.050	0.842	(0.763; 0.928)	0.001*
LDL-C	0.050	0.015	1.051	(1.020; 1.083)	0.001*
BG	-0.041	0.043	0.960	(0.882; 1.045)	0.349
MS	0.595	0.768	1.814	(0.403; 8.170)	0.438

*Note: * p < 0.05 was considered statistically significant. Adjusted model for age, alcohol intake and smoking; Due to the nature of the data, the variable WHR was not considered. SBP - Systolic Blood Pressure; HDL-C - High Density Lipoproteins cholesterol; LDL-C - Low Density Lipoproteins Cholesterol; BG Blood Glucose; MS - Metabolic Syndrome.*

The association between age and the significant factors in steps one or two in 2015 was analyzed, in order to see whether closer monitoring of a particular group is needed. For this, the individuals were classified into two groups according to their median age (Group 1: individuals aged 38 years or less; Group 2: individuals aged over 38 years). From Table 7, it is possible to notice that there is a significant association between age and blood glucose levels (p = 0.006), alcohol intake (p = 0.040) and smoking (p = 0.004).

Table 7: Significant factors stratified by age in 2015

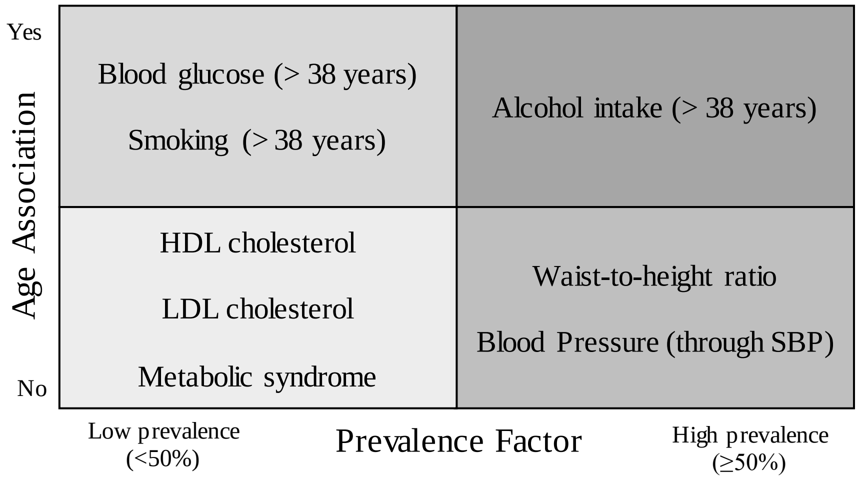
	≤ 38 years (N = 106)	> 38 years (N = 85)	p-value
WHR	0.53 (0.50 - 0.57)	0.54 (0.51 - 0.59)	0.112
SBP (mmHg)	135.8 (126.0 - 144.0)	135.0 (126.0 - 142.0)	0.850
HDL-C (mg/dL)	52.6 (45.6 - 60.0)	51.8 (43.6 - 59.6)	0.248
LDL-C (mg/dL)	112.4 (89.5 - 133.6)	118.2 (92.7 - 136.9)	0.502
BG (mg/dL)	87.9 (83.1 - 92.3)	91.8 (85.4 - 97.3)	0.006*
MS (%)			0.958
No	60.4	60.0	
Yes	39.6	40.0	
Alcohol intake (%)			0.040*
No	38.7	24.7	
Yes	61.3	75.3	
Smoking (%)			0.004*
No	92.5	77.6	
Yes	7.5	22.4	

*Notes: * p < 0.05 was considered statistically significant. Results expressed as median and interquartile range. WHR - Waist-to-Height Ratio; SBP - Systolic Blood Pressure; HDL-C - High Density Lipoproteins Cholesterol; LDL-C - Low Density Lipoproteins Cholesterol; BG - Blood Glucose; MS Metabolic Syndrome.*

Source: Author

With these analyses, a model (Figure 3) was developed to assist decision-making during the CVDs risk management in this population. The X-axis of the matrix indicates the prevalence of the risk factor. It is suggested that interventions of greater intensity be carried out for risk factors with a higher prevalence in the population, in order to reach the largest number of individuals. The Y-axis indicates whether the analyzed factor is associated with a certain group of individuals (according to age). In this sense, it is suggested that, if a factor has an association, closer monitoring may be carried out in the group in which it has the highest prevalence. Therefore, interventions of greater intensity are indicated to reduce alcohol intake, arterial hypertension, and WHR levels, since these factors have a prevalence above 50% in 2015. Lesser-intensity interventions may be performed to reduce levels of HDL-C and LDL-C, BG, prevalence of MS, and smoking. However, individuals over 38 years old who have high BG levels, who consume alcohol beverages or smoke should be monitored more closely.

Figure 3: Cardiovascular risk management aid model



Notes: HDL - High Density Lipoproteins; LDL - Low Density Lipoproteins; SBP – Systolic Blood Pressure.
Source: Author

Finally, a retrospective risk analysis was performed, viewing the model presented in a longitudinal way, for the same group of workers. Thus, it may be seen that the variables MS e BP (through SBP) in 2010 and the variables BG and BP (through SBP) in 2012 remained in the same quadrant. In addition, despite not belonging to the same quadrant, the variables HDL-C and smoking were also present in the model in 2010. The same occurred with the risk factors WHR, smoking and MS in 2012.

4.3. RISK TREATMENT

Through risk assessment it was possible to identify that age, waist-to-height ratio, reduced HDL cholesterol levels, high systolic blood pressure, high LDL cholesterol and blood glucose are associated with a moderate or high risk of developing cardiovascular diseases in the studied population. In addition, the presence of metabolic syndrome, alcohol consumption and smoking are also factors associated with this risk.

Of these factors, only age is an unmodifiable factor. In this sense, it is indicated that prevention measures focus on reducing the prevalence of modifiable factors associated with a higher risk in this population. Therefore, preventive actions focused on the work environment may include advice on healthier lifestyle habits, mainly related to a more balanced diet and physical activity. The employees themselves, through the encouragement of leaders, can carry out campaigns for healthy habits as well as smoking cessation. This will allow greater participation of workers in health management as well as greater learning in relation to the prevention of cardiovascular diseases.

In addition, it is suggested that the snacks and other meals offered by the company be composed of healthy foods and with reduced energy, fat and sodium levels. It is also important that employees feel they have support in this prevention process. Therefore, it is necessary that they have the aid of the occupational health team, through consultations or availability to answer any questions.

Finally, it is important to note that work conditions that generate a high level of stress may be associated with risk factors for the development of cardiovascular diseases, such as high blood pressure. Therefore, it is important to pay attention to the possible conditions that may generate stress for the worker and make changes in order to reduce cardiovascular risk. If encouraged by the leadership, employees themselves can act on these changes in the work environment through continuous improvement projects, for example.

5. DISCUSSION

A good OHS performance is important for a company, as it can reduce the risks of accidents and illness, promoting the workers' satisfaction and improving the company's image (DA SILVA; AMARAL, 2019). Moreover, the injuries, illnesses, and deaths caused by poor OHS management cause human suffering and result in economic costs not only for the individual but also for the company, government, and society (DE WEERD et al., 2014). In this sense, the OHS management has gained more prominence in the business environment, since it may increase the competitiveness and productivity of companies. Besides, although ISO 31000:2018 indicates that a risk may bring negative or positive consequences, in the OHS context they are always negative (ROBERTS, 2015). Thus, a proactive approach is necessary, analyzing the risks and including preventive actions (GÜL; AK, 2018).

Therefore, this work proposed a model to assist the risk management of the cardiovascular disease development in a team of off-road truck operators of a mining company located in Brazil. For this, a study of the cardiovascular risk of 191 workers was carried out. The developed model brings an important contribution in managing a risk that directly affects the lives and well-being of individuals who are essential to the country's business and economy. Off-road truck operators operate at the beginning of the mining process, being responsible for the daily transport of tons of a commodity used worldwide. Additionally, they operate in a sector responsible for an important share of GDP in Brazil and for generating a considerable number of jobs in the country. Lastly, the mining sector is present in several locations around the world, so this work offers an insight into the management of cardiovascular risk that may be reproduced in other countries.

In addition, this work contributes to the expansion of literature in the area of cardiovascular risk management in the occupational context through a longitudinal study. Therefore, it was possible to monitor the progress of the risk of developing CVDs in three phases (2010, 2012 and 2015). The use of the risk management process will assist in the analysis of the available information and it will support decision-making. Moreover, when it comes to CVDs, preventive risk management becomes even more important, especially in low and middle-income countries that have limited resources. This is because the costs associated with the disease treatment and correction of failures tend to be higher than the investment in prevention. Therefore, the use of models that assist risk management allows a more efficient use of available resources.

It was possible to identify, during the follow-up period, an increase in the prevalence of individuals at moderate risk of developing CVDs, with a prevalence of 34.6% of individuals at moderate risk in 2015. Also, at the end of the follow-up, individuals with high cardiovascular risk were identified, reaching a prevalence of 2.1%. The proportion of individuals at moderate risk in 2015 is higher than that found by Babatunde et al. (2020) in a study carried out with workers in Nigeria and by Guerra-Silva et al. (2017) in a study carried out with men living in the state of Paraná, Brazil. The prevalence of individuals at high risk found in this study is lower than that found by these two authors.

Due to the increased risk of developing CVDs in this population during follow-up, the factors associated with moderate and high risks in 2015 were analyzed. This action is relevant, as according to the Ministry of Health (BRASIL, 2006) for the moderate and high risks of developing CVDs it is suggested to intensify counseling aimed at adopting healthier lifestyle habits. In this sense, companies have an important role in the adoption and intensification of these measures, since workers spend significant hours of their daily lives in the work environment.

WHO (2017) presents several risk factors for the development of CVDs, such as smoking, alcoholism, hypertension, high blood glucose, dyslipidemia, overweight, and obesity, among others. In this sense, this work makes an important contribution by indicating which of these factors are associated with an increased risk of developing CVDs in this population. This identification allows for more effective and efficient prevention actions. This is because the investments will be aimed at reducing or eliminating the most serious risk factors for the health of these workers.

The results showed that it is possible to prevent CVDs more efficiently. Of the seventeen factors analyzed, only eight modifiable factors were associated with a higher cardiovascular risk in this population. Therefore, it is possible to carry out interventions for the prevention of CVDs that are focused on these risk factors. In addition, some factors, due to their higher prevalence, require more investments through interventions of greater intensity. The results also indicated that interventions aimed at reducing some risk factors must be differentiated according to the age of the individuals. Through the developed model it was possible to identify the need to develop interventions that reduce the levels of smoking and blood glucose (especially among individuals over 38 years old), metabolic syndrome, LDL and HDL cholesterol in the studied population. Also, more intense interventions are needed to reduce the prevalence of alcohol consumption (especially among people over 38 years old), raised blood pressure, and waist-to-height ratio.

Since WHR is an indicator of abdominal obesity, the association between increased cardiovascular risk and WHR is in line with the Ministry of Health (BRASIL, 2006), which indicates abdominal obesity as a risk factor. The values of WHR of individuals in 2015 were higher than those that were found in a study conducted with shift workers in Brazil (SOUZA et al., 2015). The associations identified between risk and blood pressure and smoking are in line with a study carried out by Guerra-Silva et al. (2017) among men in a state of Brazil. In addition, the high prevalence of arterial hypertension, found in this study, is much higher than that found in the male population of Brazil (BRASIL, 2019) and that found in people living in middle-income countries, including Brazil (YUSUF et al., 2020).

The LDL cholesterol and blood glucose are factors that also need to be reduced in this population. This result is in line with a study conducted with predominantly male taxi drivers in the USA, which found an association between the high cardiovascular risk profile and the presence of diabetes and hyperlipidemia (ELSHATARAT; BURGEL, 2016). The relationship of alcohol intake with cardiovascular risk was not in line with a study carried out with workers in Nigeria (BABATUNDE et al., 2020), but it was found in the study carried out by Elshatarat and Burgel (2016). Moreover, its high prevalence was not found in the middle-income countries, including Brazil (YUSUF et al., 2020).

The results showed that interventions are needed to increase HDL cholesterol levels among operators. This was already expected, since HDL cholesterol levels are used to calculate cardiovascular risk. The presence of metabolic syndrome was also a significant predictor of an increased cardiovascular risk in this study. This result was expected since the metabolic syndrome, according to the Ministry of Health, describes a set of factors that increase the risk of developing heart disease (BRASIL, 2018). Besides, a study with bus drivers from Taiwan identified a significant association between the presence of metabolic syndrome and the development of CVDs during an 8-year follow-up (CHEN et al., 2018). Table 8 presents a summary of the results found in this study and in the literature.

Table 8: Comparison of results and literature

Study results	Literature results	Discussion
Moderate risk Prevalence = 34.6%	8.5% (BABATUNDE et al., 2020) 12.56% (GUERRA-SILVA et al., 2017)	The prevalence of individuals at moderate risk was higher than that found by some studies in the literature, but the prevalence of high cardiovascular risk was lower.
High risk Prevalence = 2.1%	14.6% (BABATUNDE et al., 2020) 5.49% (GUERRA-SILVA et al., 2017)	
BP OR = 1.028 (1.01-1.05)	OR = 5.42 (3.46-8.47) (GUERRA-SILVA et al., 2017)	In general, the associations found in this work are in line with some studies present in the literature. However, Babatunde et al. (2020) did not find an association between risk and alcohol consumption.
Smoking OR = 14.314 (4.70-43.63)	OR = 2.59 (1.63-4.12) (GUERRA-SILVA et al., 2017)	
BG and diabetes Chi-Square p-value = 0.008	Chi-Square p-value < 0.05 (ELSHATARAT; BURGEL, 2016)	
LDL-C and hyperlipidemia Chi-Square p-value = 0.009	Chi-Square p-value < 0.05 (ELSHATARAT; BURGEL, 2016)	
MS OR = 1.951 (1.07-3.56)	OR = 1.77 (1.12-2-79) (CHEN et al., 2018)	
Alcohol intake Chi-Square p-value = 0.031	Chi-Square p-value = 0.367 (BABATUNDE et al., 2020) Chi-Square p-value < 0.05 (ELSHATARAT; BURGEL, 2016)	
Alcohol intake prevalence 67.5%	27.7% (YUSUF et al., 2020)	The high prevalence or values of some of the factors associated with cardiovascular risk were not found in other studies in the literature.
WHR levels Mean = 0.54; SD = 0.05	Mean = 0.53; SD = 0.05 (SOUZA et al., 2015)	
High BP prevalence 69.1%	22.1% (BRASIL, 2019) 42.2% (YUSUF et al., 2020)	

Notes: OR – Odds Ratio; BP - Blood Pressure; BG - Blood Glucose; LDL-C – Low Density Lipoproteins Cholesterol; MS Metabolic Syndrome; WHR – Waist-to-Height Ratio.

Source: Author

Finally, some prevention actions were suggested, within the business context. Counseling and campaigns that encourage healthier habits, including worker participation, were indicated. This action is important since it will allow that workers acquire knowledge about CVDs risk factors and about how to prevent them.

Considering the current use of technology and means of communication over the internet, some guidelines may be passed through these means. A systematic review by Aneni et al. (2014) indicated that internet-based CVDs prevention programs were most successful when interventions also included some physical contact, environmental modification and were targeted at specific risk factors (for example, hypertension or smoking). These guidelines via the internet may facilitate access to the information of workers who do not have fixed hours regarding the change in lifestyle and how to deal with risk factors in a preventive way. Therefore, internet-based intervention programs, in combination with activities in the workplace, may be important for shift workers.

Another proposed action is to encourage, through leadership, the development of projects for continuous improvement in the work environment that may reduce stress, being carried out by workers. This action is relevant since workers involvement can bring positive results to OHS (HASSAM et al., 2018). A study by von Thiele Schwarz et al. (2017) identified that participatory interventions, using tools such as Kaizen, may present improvements in the management of psychosocial risks and the well-being of workers. The incentive provided by the leadership is also an important role in this intervention. A study by Skład (2019) found that leadership has a positive impact on the effectiveness of an OHS management system. In addition, according to Dietz et al. (2020), leaders may affect the health of employees through their behavior, the creation or alteration of the work environment, and role modeling.

Additionally, according to the SBC (PRÉCOMA et al., 2019), the presence of psychosocial factors, such as stress at work, increases the risk for high blood pressure, also increasing the risk of developing CVDs. Also, research has already identified the relationship between stress at work and CVDs (CHEN et al., 2018; KIVIMÄKI; KAWACHI, 2015). Salanova et al. (2016) argue that non-abusive working conditions may prevent cardiovascular risks caused by the deregulation of the physiology of stress. Thus, continuous improvement projects aimed at reducing stressful situations in the occupational environment and the engagement of workers in occupational health management may prevent CVDs.

Finally, actions involving changes in the food offered in the workplace were indicated, as well as the support of the occupational health team in the process of smoking cessation and the adoption of healthier habits. These actions are important because the work environment may support healthy behaviors through tobacco control policies in the workplace, as well as the provision of healthy food in cafeterias (SORENSEN et al., 2016). In addition, a survey conducted by Reader et al. (2017) showed that when the company develops actions aimed at occupational health, employees perceive greater support from the organization and, consequently, are more committed to safety behaviors. Therefore, support for workers' health may also bring positive results for occupational safety.

5.1. LIMITATIONS AND FUTURE RESEARCH

This study has some limitations that must be taken into account. The model presented took into account data from off-road truck operators in the mining sector. Therefore, care must be taken when generalizing the results to another population of workers. In this sense, future research may create models that assist the management of cardiovascular risk in other sectors and in workers who perform other functions.

The analysis of some risk factors presented by the WHO (2017) was not part of the scope of this work. Thus, psychosocial factors and factors such as physical inactivity and diet could also be significantly associated with cardiovascular risk. Therefore, the next researches may consider these factors. It was also not in the scope of this study to compare cardiovascular risk with the risk of developing other diseases. Therefore, in the future, the elaboration of ways that allow this comparison and consequent prioritization of actions is indicated.

In addition, carrying out the suggested risk reduction actions was not part of the scope of this work. Therefore, future research may apply the suggested actions in order to assess the impact on risk reduction. Finally, this study evaluated only the time on shift work as an occupational factor. However, factors such as long working hours and stress at work have already been presented as possible aggravating cardiovascular risk. Therefore, future models of aid for cardiovascular risk management may consider these occupational factors.

6. FINAL CONSIDERATIONS

The present study developed, through a longitudinal study carried out in three phases (2010, 2012 and 2015), a model to assist the risk management of CVDs in a team of off-road-truck operators working in a mining company. For this, risk factors for CVDs of 191 operators who work in rotation shifts was assessed. In addition, cardiovascular risk over the three years was calculated and due to the significant increase in 2015, the factors associated with risk in that year were analyzed. Finally, some actions were suggested to reduce cardiovascular risk in this population. The use of the steps proposed by ISO 31000 helped in the creation of the model, offering a practical and systematic guide for the analysis of the available data.

This study contributes to the OHS risk management literature, expanding studies aimed at preventing and promoting worker health. In addition, it contributes to the CVDs literature in shift workers, bringing this issue from a managerial point of view. The study has a social impact, affecting the health and well-being of these workers. In addition, considering the current pandemic context, this work may have an impact on public health, since CVDs and some of its risk factors are associated with the development of complications in individuals with COVID-19.

Finally, the study also brings managerial contributions. The developed model assists in decision making when managing the cardiovascular risk of the employees of a company. In addition, it allows the use of available resources more effectively and efficiently, focusing on the factors that are associated with increased cardiovascular risk in this population.

The evaluation of different indicators that explain each risk factor was important to confirm the association, or not, of a certain factor with cardiovascular risk. A clear example of this importance concerns the risk factor for abdominal obesity. The WC indicator was not associated with risk, but the WHR indicator is significantly associated, confirming that abdominal obesity is an important factor when assessing cardiovascular risk. However, the fact that the analyzed variables are interrelated may create multicollinearity problems when performing multivariate regressions.

Through the study, it was possible to identify that the factors that generate a greater risk in these individuals are high LDL cholesterol, reduced HDL cholesterol and the presence of metabolic syndrome. Smoking, alcohol consumption and high glucose levels are also factors that contribute to a high risk and are prevalent mainly in individuals over 38 years of age. In addition, regular or poor WHR, alcohol consumption and high blood pressure are also factors associated with risk that are highly prevalent in the population studied. In a longitudinal perspective, the variables MS and BP (through SBP) in 2010 and the variables BG and BP (through SBP) in 2012 remained in the same quadrant. Also, despite not belonging to the same quadrant, the variables HDL-C, WHR and smoking are present in the model in at least one of the other two years of follow-up. Therefore, interventions within the business context should focus on improving these factors, seeking the participation of workers in this process and the support of the leadership and the company.

However, this work also has some limitations. The study was carried out with a specific team from the mining sector. Not all possible risk factors (behavioral and occupational) for CVDs were analyzed. Additionally, it was not part of the scope of this study to apply the suggested actions. Therefore, future studies can cover these limitations, bringing an analysis of cardiovascular risk in other teams and sectors; checking the association of factors such as physical activity, food and work stress; and applying and evaluating the proposed actions for risk reduction.

7. CONSIDERAÇÕES FINAIS

O presente estudo desenvolveu, através de um estudo longitudinal realizado em três fases (2010, 2012 e 2015), um modelo para auxiliar o gerenciamento de risco de DCVs em um time de operadores de caminhão fora-de-estrada que trabalham em uma empresa de mineração. Para isso, foi avaliado o estado nutricional de 191 operadores que trabalham em turnos alternantes. Além disso, o risco cardiovascular nos três anos foi calculado e devido ao aumento significativo em 2015, os fatores associados ao risco nesse ano foram analisados. Por fim, foram sugeridas algumas ações que visam a redução do risco cardiovascular nessa população. A utilização dos passos propostos pela ISO 31000 auxiliaram na criação do modelo, oferecendo um guia prático e sistemático para a análise dos dados disponíveis.

Esse estudo contribui para a literatura de gerenciamento de riscos de SSO, expandindo os estudos voltados para a prevenção e promoção da saúde do trabalhador. Além disso, contribui para a literatura de DCVs em trabalhadores de turno, trazendo essa problemática através de um ponto de vista gerencial. O estudo possui um impacto social, afetando a saúde e o bem-estar desses trabalhadores. Além disso, considerando o atual contexto de pandemia, esse trabalho pode impactar na saúde pública, pois as DCVs e alguns de seus fatores de risco estão associados ao desenvolvimento de complicações em indivíduos com Coronavírus.

Por fim, o estudo também traz contribuições gerenciais. O modelo desenvolvido auxilia na tomada de decisão ao gerenciar o risco cardiovascular dos funcionários de uma empresa. Além disso, ele permite uma utilização de recursos disponíveis de maneira mais eficaz e eficiente, focando nos fatores que estão associados com o aumento do risco cardiovascular nessa população.

A avaliação de diferentes indicadores que explicam cada fator de risco foi importante para confirmar a associação, ou não, de determinado fator com o risco cardiovascular. Um exemplo claro dessa importância diz respeito ao fator de risco de obesidade abdominal. O indicador PC não apresentou associação com o risco, porém o indicador RCE está significantemente associado, confirmando que a obesidade abdominal é um fator importante ao avaliar o risco cardiovascular. Porém, o fato de as variáveis analisadas serem inter-relacionadas, pode criar problemas de multicolinearidade ao realizar regressões multivariadas.

Através do estudo, foi possível identificar que os fatores que geram um maior risco nesses indivíduos são o alto LDL-C, reduzido HDL-C e a presença de síndrome metabólica. Tabagismo, consume alcoólico e elevado nível de glicose também são fatores que contribuem com um risco elevado e são prevalentes principalmente em indivíduos acima de 38 anos de idade. Além disso, razão cintura-estatura regular ou ruim, consumo alcoólico e elevada pressão arterial também são fatores associados com o risco que são altamente prevalentes na população estudada. Em uma perspectiva longitudinal, as variáveis SM e PA (pela PAS) em 2010 e as variáveis GS e PA (pela PAS) em 2012 permaneceram no mesmo quadrante. Ainda, apesar de não pertencerem ao mesmo quadrante, as variáveis HDL-C, RCE e tabagismo estão presentes no modelo em pelo menos um dos outros dois anos de acompanhamento. Portanto, as intervenções no contexto empresarial devem ter como foco a melhoria desses fatores, buscando a participação dos trabalhadores neste processo e o apoio da liderança e da empresa.

Porém, esse trabalho também apresenta algumas limitações. O estudo foi realizado com uma equipe específica do setor de mineração. Não foram analisados todos os possíveis fatores de risco (comportamentais e ocupacionais) para as DCVs. Adicionalmente, não foi parte do escopo desse estudo aplicar as ações sugeridas. Portanto, estudos futuros podem cobrir essas limitações, trazendo uma análise do risco cardiovascular em outras equipes e setores; verificando a associação de fatores como atividade física, alimentação e estresse no trabalho; e aplicando e avaliando as ações propostas para a redução do risco.

REFERENCES

ANENI, E. C. et al. A systematic review of internet-based worksite wellness approaches for cardiovascular disease risk management: Outcomes, challenges & opportunities. **PLoS ONE**, v. 9, n. 1, p. e83594, 2014.

AVEN, T. Risk assessment and risk management: Review of recent advances on their foundation. **European Journal of Operational Research**, v. 253, n. 1, p. 1–13, 2016.

BABATUNDE, O. A. et al. 10-year risk for cardiovascular diseases using WHO prediction chart: Findings from the civil servants in South-western Nigeria. **BMC Cardiovascular Disorders**, v. 20, n. 1, p. 1–10, 2020.

BABOR, T. F. et al. T**he alcohol use disorders identification test (AUDIT),** 1-37. Geneva: World Health Organization, 2001.

BADRI, A. The challenge of integrating ohs into industrial project risk management: Proposal of a methodological approach to guide future research (case of mining projects in Quebec, Canada). **Minerals**, v. 5, n. 2, p. 314–334, 2015.

BARAFORT, B.; MESQUIDA, A. L.; MAS, A. Integrating risk management in IT settings from ISO standards and management systems perspectives. **Computer Standards and Interfaces**, v. 54, p. 176–185, 2017.

BRASIL. **Prevenção clínica de doenças cardiovasculares, cerebrovasculares e renais**. Brasil: Ministério da Saúde, 2006.

BRASIL. **Síndrome Metabólica**. Disponível em: <http://bvsms.saude.gov.br/dicas-em-saude/2610-sindrome-metabolica>. Acesso em: 4 maio. 2020.

BRASIL. **Vigitel: Vigilância de fatores de risco e proteção para doenças crônicas por inquerito telefônico**. Ministério da Saúde, 2019.

CHEN, H. et al. Comparative study on the strands of research on the governance model of international occupational safety and health issues. **Safety Science**, v. 122, p. 104513, 2020.

CHEN, W. L. et al. The impact of occupational psychological hazards and metabolic syndrome on the 8-year risk of cardiovascular diseases—A longitudinal study. **PLoS ONE**, v. 13, n. 8, p. e0202977, 2018.

DA SILVA, S. L. C.; AMARAL, F. G. Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature. **Safety Science**, v. 117, p. 123–132, 2019.

DE OLIVEIRA, P. K. et al. Occupational Health and Safety in Aquaculture: Insights on Brazilian Public Policies. **Journal of Agromedicine**, v. 22, n. 2, p. 148–158, 2017a.

DE OLIVEIRA, U. R. et al. The ISO 31000 standard in supply chain risk management. **Journal of Cleaner Production**, v. 151, p. 616–633, 2017b.

DE WEERD, M. et al. **Estimating the cost of accidents and ill-health at work: A review of methodologies.** European Agendy for Safety and Health at Work, 2014.

DIETZ, C. et al. Leaders as role models: Effects of leader presenteeism on employee presenteeism and sick leave. **Work & Stress**, p. 1–23, 2020.

ELSHATARAT, R. A.; BURGEL, B. J. Cardiovascular Risk Factors of Taxi Drivers. **Journal of Urban Health**, v. 93, n. 3, p. 589–606, 2016.

FALUDI A.A., et al. Atualização da Diretriz Brasileira de Dislipidemias e Prevenção da Aterosclerose. Sociedade Brasileira de Cardiologia. **Arquivos Brasileiros de Cardiologi**a, v.109, n. 2, p. 1-76, 2017.

GUERRA-SILVA, N. M. M. et al. Coronary disease risk assessment in men: Comparison between ASCVD Risk versus Framingham. **International Journal of Cardiology**, v. 228, p. 481–487, 2017.

GUL, M.; AK, M. F. A comparative outline for quantifying risk ratings in occupational health and safety risk assessment. **Journal of Cleaner Production**, v. 196, p. 653–664, 2018.

HASSAM, S. F. et al. Factors that lead to the supply chain safety compliance in Air Cargo Industry. **International Journal of Supply Chain Management**, v. 7, n. 6, p. 254–266, 2018.

IDF. **The IDF consensus worldwide definition of the metabolic syndrome**. IDF Communications, 2006.

İNAN, U. H.; GÜL, S.; YILMAZ, H. A multiple attribute decision model to compare the firms' occupational health and safety management perspectives. **Safety Science**, v. 91, p. 221–231, 2017.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). **Tabelas Completas do Sistema de Contas Nacionais Trimestrais**. Disponível em: <https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/9300-contas-nacionais-trimestrais.html?=&t=resultados>. Acesso em: 7 maio. 2020.

INSTITUTO BRASILEIRO DE MINERAÇÃO (IBRAM). **Economia Mineral**. Disponível em: <http://portaldamineracao.com.br/wp-content/uploads/2019/07/numeros-jun2019.pdf>. Acesso em: 10 maio. 2020.

ISO 31000: Risk management: Guidelines. International Organization for Standardization, 2018.

KASSIR, R. Risk of COVID-19 for patients with obesity. **Obesity Reviews**, v. 21, n. 6, p. 10–11, 2020.

KIVIMÄKI, M.; KAWACHI, I. Work Stress as a Risk Factor for Cardiovascular Disease. **Current Cardiology Reports**, v. 19, n. 9, p. 74, 2015.

KUDEL, I. et al. The association between body mass index and health and economic outcomes in Brazil. **Diabetology & Metabolic Syndrome**, v. 10, n. 1, p. 1–11, 2018.

LEE, J. T. et al. Are cardiovascular disease risk assessment and management programmes cost effective? A systematic review of the evidence. **Preventive Medicine**, v. 99, p. 49–57, 2017.

LUTHRA, S. et al. An integrated framework for sustainable supplier selection and evaluation in supply chains. **Journal of Cleaner Production**, v. 140, p. 1686–1698, 2017.

MOATARI-KAZEROUNI, A.; CHINNIAH, Y.; AGARD, B. A proposed occupational health and safety risk estimation tool for manufacturing systems. **International Journal of Production Research**, v. 53, n. 15, p. 4459–4475, 2015.

MODESTI, P. A. et al. Cardiovascular risk assessment in low-resource settings: A consensus document of the European Society of Hypertension Working Group on Hypertension and Cardiovascular Risk in Low Resource Settings. **Journal of Hypertension**, v. 32, n. 5, p. 951–960, 2014.

OLECHOWSKI, A. et al. The professionalization of risk management: What role can the ISO 31000 risk management principles play? **International Journal of Project Management**, v. 34, n. 8, p. 1568–1578, 2016.

OZTURKOGLU, Y.; KAZANCOGLU, Y.; OZKAN-OZEN, Y. D. A sustainable and preventative risk management model for ship recycling industry. **Journal of Cleaner Production**, v. 238, p. 117907, 2019.

PAPAZOGLOU, I. A. et al. Quantitative occupational risk model: Single hazard. **Reliability Engineering and System Safety**, v. 160, p. 162–173, 2017.

POLLACK, K. M. et al. Implementing risk management to reduce injuries in the U.S. Fire Service. **Journal of Safety Research**, v. 60, p. 21–27, 2017.

POPLIN, G. S. et al. Establishing a proactive safety and health risk management system in the fire service. **BMC Public Health**, v. 15, n. 1, p. 407, 2015.

PRÉCOMA, D. B. et al. Atualização da Diretriz de Prevenção Cardiovascular da Sociedade Brasileira de Cardiologia – 2019. **Arquivos Brasileiros de Cardiologia**, v. 113, n. 4, p. 787–891, 2019.

RABACOW, F. M. et al. The influence of lifestyle and gender on sickness absence in Brazilian workers. **BMC Public Health**, v. 14, n. 1, p. 317, 2014.

READER, T. W. et al. Organizational support for the workforce and employee safety citizenship behaviors: A social exchange relationship. **Human Relations**, v. 70, n. 3, p. 362–385, 2017.

ROBERTS, D. Risk management and electrical safety: Implementation of an occupational health and safety management system. **IEEE Industry Applications Magazine**, v. 21, n. 3, p. 67–74, 2015.

RODRIGUEZ-FERNANDEZ, R. et al. Non-communicable disease risk factor patterns among Mining industry workers in Papua, Indonesia: Longitudinal findings from the Cardiovascular Outcomes in a Papuan Population and Estimation of Risk (COPPER) Study. **Occupational and Environmental Medicine**, v. 72, n. 10, p. 728–735, 2015.

SACRAMENTO-PACHECO, J. et al. Cardiovascular risk assessment tools: A scoping review. **Australian Critical Care**, v. 32, n. 6, p. 540–559, 2019.

SALANOVA, M. et al. Your work may be killing you! Workaholism, sleep problems and cardiovascular risk. **Work and Stress**, v. 30, n. 3, p. 228–242, 2016.

SANTOS, R. B.; DE OLIVEIRA, U. R. Analysis of occupational risk management tools for the film and television industry. **International Journal of Industrial Ergonomics**, v. 72, p. 199–211, 2019.

SCHNALL, P. L.; DOBSON, M.; LANDSBERGIS, P. Globalization, Work, and Cardiovascular Disease. **International Journal of Health Services**, v. 46, n. 4, p. 656–692, 2016.

SIMÃO, A. F. et al. I Diretriz Brasileira de Prevenção Cardiovascular. Sociedade Brasileira de Cardiologia. **Arquivos Brasileiros de Cardiologia**, v. 101, n. 6, p. 1-63, 2013.

SIQUEIRA, A. DE S. E.; DE SIQUEIRA-FILHO, A. G.; LAND, M. G. P. Análise do impacto econômico das doenças cardiovasculares nos últimos cinco anos no brasil. **Arquivos Brasileiros de Cardiologia**, v. 109, n. 1, p. 39–46, 2017.

SKŁAD, A. Assessing the impact of processes on the Occupational Safety and Health Management System's effectiveness using the fuzzy cognitive maps approach. **Safety Science**, v. 117, p. 71–80, 2019.

Sociedade Brasileira de Pneumologia e Tisiologia (SBPT). Diretrizes clínicas na saúde suplementar–tabagismo. **Rev Assoc Med Bras**, v. 56, n. 4, 375-93, 2011.

SOCIEDADE DE CARDIOLOGIA DO ESTADO DO RIO DE JANEIRO (SOCERJ). **Manual de Prevenção Cardiovascular**, 2017.

SORENSEN, G. et al. Integrating worksite health protection and health promotion : A conceptual model for intervention and research. **Preventive Medicine**, v. 91, p. 188–196, 2016.

SOUSA, V.; ALMEIDA, N. M.; DIAS, L. A. Risk-based management of occupational safety and health in the construction industry - Part 1: Background knowledge. **Safety Science**, v. 66, p. 75–86, 2014.

SOUSA, V.; ALMEIDA, N. M.; DIAS, L. A. Risk-based management of occupational safety and health in the construction industry - Part 2: Quantitative model. **Safety Science**, v. 74, p. 184–194, 2015.

SOUZA, B. B. et al. Lifetime shift work exposure : association with anthropometry , body composition , blood pressure , glucose and heart rate variability. **Occupational and Environmental Medicine**, v. 72, n. 3, p. 208–215, 2015.

SPARER, E. H. et al. The relationship between organizational policies and practices and work limitations among hospital patient care workers. **American Journal of Industrial Medicine**, v. 61, n. 8, p. 691–698, 2018.

STEVENS, B. et al. The economic burden of heart conditions in Brazil. **Arquivos Brasileiros de Cardiologia**, v. 111, n. 1, p. 29–36, 2018.

TCHIEHE, D. N.; GAUTHIER, F. Classification of risk acceptability and risk tolerability factors in occupational health and safety. **Safety Science**, v. 92, p. 138–147, 2017.

TORQUATI, L. et al. Shift work and the risk of cardiovascular disease. A systematic review and meta-analysis including dose–response relationship. **Scand J Work Environ Health**, v. 44, n. 3, p. 229–238, 2018.

TSUTSUMI, A. Prevention and management of work-related cardiovascular disorders. **International Journal of Occupational Medicine and Environmental Health**, v. 28, n. 1, p. 4–7, 2015.

US DEPARTMENT OF HEALTH AND HUMAN SERVICES. **Understanding Adult Obesity**. Disponível em: <http://win.niddk.nih.gov/publications/PDFs/adultobesbw1201.pdf>. Acesso em: 18 fev. 2020.

VON THIELE SCHWARZ, U. et al. Using kaizen to improve employee well-being: Results from two organizational intervention studies. **Human Relations**, v. 70, n. 8, p. 966–993, 2017.

WANG, B. et al. Does comorbidity increase the risk of patients with covid-19: Evidence from meta-analysis. **Aging**, v. 12, n. 7, p. 6049–6057, 2020.

WANG, D. et al. Shift work and risk of cardiovascular disease morbidity and mortality: A dose–response meta-analysis of cohort studies. **European Journal of Preventive Cardiology**, v. 25, n. 12, p. 1293–1302, 2018.

WHO. **What is overweight and obesity?** Disponível em: <https://www.who.int/dietphysicalactivity/childhood_what/en/>. Acesso em: 20 mar. 2020.

WHO. **Global Report on Diabetes**, 2016.

WHO. **Cardiovascular diseases (CVDs)**. Disponível em: <https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)>. Acesso em: 19 nov. 2019.

XAVIER, H. et al. V Brazilian Guidelines of dyslipidemias prevention of atherosclerosis. [s.l.] Sociedade Brasileira de Cardiologia. **Arquivos Brasileiros de Cardiologia**, v. 101, n. 4, 2013.

YUSUF, S. et al. Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and low-income countries (PURE): a prospective cohort study. **The Lancet**, v. 395, n. 10226, p. 795–808, 2020.

ZHENG, Z. et al. Risk factors of critical & mortal COVID-19 cases: A systematic literature review and meta-analysis. **Journal of Infection**, v. 12, n. 7, p. 6049–6057, 2020.

ZHOU, L. J. et al. Research on occupational safety, health management and risk control technology in coal mines. **International Journal of Environmental Research and Public Health**, v. 15, n. 5, p. 868, 2018.

ZWAARD, A. J. VAN DER et al. Framingham score and work-related variables for predicting cardiovascular disease in the working population. **European Journal of Public Health**, v. 29, n. 5, p. 832–837, 2019.