Risks Associated to Blood Hypertension in Workers of Maintenance of a Mining Complex of Carbon of La Guajira Colombiana

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Abstract: To establish the prevalence of hypertension in maintenance workers of a mining complex in La Guajira Colombiana. Descriptive and inferential study, in 206 workers, of legal age, male who work in any of the fronts of work (washing of mining equipment or maintenance of civil works) with active work contract. The variables were studied: age, history of cardiovascular disease, diabetes, hypertension, smoking, consumption of liquor, BMI and glycemia. The overall risk of cardiovascular disease is established by the Framinghan Scale. The presence of hypertension was 7.4% in the population of workers. The cardiovascular risk according to the Framingham guidelines reported, a low risk in 48%, moderate in 49% and high in 3% of the population. High prevalence of risk factors of cardiovascular disease, a low prevalence is observed for pathologies such as hypertension and diabetes, this could be explained by the bias of a healthy worker, since, these companies handle strict professiograms for the entry of personnel that will develop high risk tasks.

Key words: Epidemiology, industrial maintenance, cardiovascular risk, occupational health, tasks, population

INTRODUCTION

The number of people affected by arterial hypertension amounts to approximately 50 million in the United States and 1 billion worldwide (Lavie *et al.*, 2018; Kalkhoran *et al.*, 2018). As the population ages, the prevalence of hypertension increases, unless effective and wide-ranging preventive measures are implemented (Bedoya *et al.*, 2017). Recent data from the Framingham study suggest that 90% of individuals who have normal blood pressure at age 55 will develop hypertension at some time during their lifetime (Walther *et al.*, 2017; D'Agostino *et al.*, 2013). Chronic Noncommunicable Diseases (CNCDs) play an increasingly important role within the framework of the general burden of diseases in Latin America and the Caribbean, generating 57.9% of approximately three million annual deaths from all causes (Lopez-Martinez *et al.* 2018). Of the total deaths due to NCD, cardiovascular diseases produced 45.4%, malignancies 19.7% and diabetes 4.9% according to PAHO (Boutayeb and Boutayeb, 2005; Vos *et al.*, 2017).

According to the World Health Organization (WHO) (Vos *et al.*, 2017), high blood pressure is the leading cause of death in the world with an average prevalence of 25% with a total of one billion hypertensive, a figure that will increase by 20 years in more than 50%. In Latin America, the appropriately controlled population is close to 12%. The expenses generated by this disease are very high and it is still the cause of 62% of cerebral vascular accidents

and 48% of acute myocardial infarctions (Dobashi *et al.*, 2014). Likewise, the technical report of the National Health Observatory of 2015 for Colombia, indicates that the overload of chronic non-communicable diseases and disability in Colombia in 2015 (Nahimana *et al.*, 2018), found that in men, the projections obtained from the systematic review showed prevalences that they oscillated between 25 and 37% in the groups of 20-24 and 75-79 years, respectively. By this method, the first 5 years groups with highest prevalence of HT were in their order those of 65-69, 75-79, 60-64, 70-74 and 55-59 years.

According to the prevalence data estimated by RIPS in men, the number of cases ranged from 4,305 individuals in the group of 15-19 years, equivalent to a prevalence of 0.19% and 92,993 people in the group of 75-79 years, equivalent to a prevalence of 31.7% (Hernandez-Rincon *et al.*, 2017). To this end, the sociological study and the knowledge of the risk factors of cardiovascular diseases in the Colombian Caribbean Coast reported that 25.1% of the studied population had dyslipidemia (cholesterol and high triglycerides) on the 11th, 8% and diabetes. The 21% suffered from obesity and 10.1% had presented some episode of angina which shows that this problem deserves more attention in Colombia because of the future impact it can have on the costs of public health (Patino-Villada *et al.*, 2011).

The presence of intermediate risk factors in the occurrence of cardiovascular diseases facilitates the identification of cardiovascular risk. This risk in different

epidemiological studies has shown the importance of the problem (Fatema *et al.*, 2016). Of these, the best known is that of Framingham that is not completely extrapolated to Colombia, on the other hand, occupational medicine, especially as far as large companies are concerned is an ideal framework for carrying out homogeneous population studies and therefore, for the analysis of the utility of preventive measures and their impact on labor reincorporation for workers with cardiovascular disorders or a moderate or high cardiovascular risk (Berger *et al.*, 2010).

Chronic noncommunicable diseases are a risk that affects the general population and therefore the working population. There are globally jobs where the management of adequate blood pressure figures are important criteria for the development of tasks as is the case of high-risk tasks: work at heights, confined spaces or hot work, among others (Aburto *et al.*, 2013; Schmidt *et al.*, 2011). Workers with hypertension can not only affect their health when exposed to these activities but also can generate costs due to disability issues or complications of the disease to be aggravated in their work, so, despite being a disease of common origin hypertension is subject to control by the medical surveillance programs that determine companies (Khodabandeh-Shahraki and Azizzadeh-Forouzi, 2012; Ghorani-Azam *et al.* 2016). In this order of ideas the washing of equipment and maintenance of mining facilities, implies a high degree of physical effort with an important caloric wear and work in temperatures that generate thermal comfort and dehydration, conditions that affect people with hypertension diagnosis and other cardiovascular risk factors such as obesity and diabetes, generating risk of accidents or complications of the underlying disease. For all the above, the objective of this work was to establish the behavior of hypertension and recognized biological and behavioral risk factors for cardiovascular disease in a population of workers who perform operations of washing of mining equipment, construction and maintenance of works civilians in a coal mine in Albania, La Guajira, Colombia.

MATERIALS AND METHODS

Type of study: The study carried out is descriptive and inferential of transversal type.

Population and sample: The population of interest in the study corresponds to the contractor worker of a coal mine in Albania, territory of La Guajira Colombiana. The sample corresponds to 206 male workers and adults of a contractor company that performs functions of tank

Table 1: Variables considered in the study

Independents variables	Dependents variable
Triglycerides	Hypertension
Weight	
Low HDL cholesterol	
Cholesterol	
Liquor consumption	
Age	
Smoking	
Glycemia	
Working time	
Diabetes	

cleaning with sandblasting, cleaning and washing of mining operation trucks and maintenance of facilities in a mining complex.

Variables and data collection: The variables measured to workers correspond to the prevalence of hypertension and risk factors associated with it as illustrated in Table 1. The source of information is secondary, provided by the patient's occupational history. Although, the data was taken from a secondary database, it was established that these measures were taken following the techniques described below.

The blood pressure was determined with a LORD CE 123 mercury pressure gauge previously calibrated and two doses were taken with an interval of 5 min with the subject seated with a backrest in the left arm, averaging the two figures, according to the recommendations of the National Joint Committee VII. The stature was measured with a stadiometer and the weight with an electronic scale Tanita which has calibration certificate, during the moment of the weight gain the worker was without shoes, watch, wallet, shirt and belt. Venous puncture was taken to determine the level of total cholesterol, triglycerides and glycemia. We used a blood chemistry equipment model Mindray BA 88th semiautomatic Chemistry analyze series WR 35011031, performing internal controls with triglycerides, total cholesterol and Glycemia Biosystem brand. All subjects who had diastolic and systolic blood pressure values higher than 140-90 mmHg, according to the WHO dentition and who had an established diagnosis and were under medical treatment were considered hypertensive. Similarly, all subjects with values >150 mg/dL regardless of gender were considered hyper glycemic. It was considered overweight to those who had a BMI>27 kg/m.

Analysis of the information: For the analysis of the data, a descriptive analysis of the variables was initially carried out, taking into account the totals and percentages; A Pareto diagram is then made to identify the most frequent hypertension risk factors in the workers and finally a Chi-square test is made between the hypertension and the

Table 2: Description of quantitative variables

Variables	Mean	SD	Coefficient of variation (%)
Age	36.1	9.3	25.76
Labor old	2	1.6	80.00
BMI	27.3	0.2	0.73
Diastolic blood pressure	117	11	9.40
Systolic blood pressure	77	8	10.39
Cholesterol	204	45.5	22.30
HDL cholesterol	36	7	19.44

different risk factors to determine which of them have an association with hypertension. With the support of mosaic diagrams the senses of the associations found in the independence test are established. For the tabulation of the data and the analysis of the results, the Excel spreadsheet and the statistical Software SPSS V 22.0 were used.

RESULTS AND DISCUSSION

Descriptive analysis: The results obtained in the descriptive analysis of the behavior of arterial hypertension and cardiovascular risk factors in the group of workers are shown as:

Table 3 shows that on average workers have an age of 36.1 years and have a standard deviation of 9.3 years, this implies a percentage variation of 25.76%, indicating that there is no such high variation for age. With regard to seniority, it is observed that on average workers have 2 years of work and show a deviation of 1.6 years which is a high variability (80%), indicating that there is a lot of dispersion with respect to the labor old. The mean values for diastolic and systolic blood pressure, respectively are 77 and 204; presenting percentages of variation below 11%. For cholesterol and HDL cholesterol averages of 204 and 36 are observed, respectively and variations below 23% (22.3% and 19.44%, respectively).

According to these results, it is observed that among the workers considered 15, they have a prevalence of arterial hypertension which corresponds to 7.28%. With regard to the different risk factors associated with hypertension, it is observed that the risks that should be considered of greatest concern are physical inactivity (100%) high triglycerides (51.46%), overweight (63.59%), high cholesterol (44.17%), low HDL cholesterol (47.09%) and liquor consumption (33.5%).

Next, the mosaic charts between hypertension and the different risk factors considered are observed, to observe the sense of the relationships found in the test. Figure 1 shows that the main risks present in workers are high levels of triglycerides, overweight, low HDL cholesterol, high cholesterol and liquor content.

Tabla 3: Descriptive statistics of the behavior of hypertension and cardiovascular risk factors

	Yes		No	
Risk factors	Fr	Percentage	Fr	Percentage
High triglycerides	106	51.46	100	48.54
Physical inactivity	206	100	0%	0
Overweight	131	63.59	75	36.41
Low HDL cholesterol	97	47.09	109	52.91
High cholesterol	91	44.17	115	55.83
Liquor consumption	69	33.50	137	66.50
More than 50 years old	13	6.31	193	93.69
Smoking	8	3.88	198	96.12
High blood glucose level	5	2.43	201	97.57
More than 8 years of work	4	1.94	202	98.06
Diabetes	3	1.46	203	98.54
Hypertension	15	7,28	192	92,72

Table 4: p-values for the Chi-square test between hypertension and risk factors

Risk factors	p-values
High triglycerides	8.1889E-79***
Overweight	0.0004233***
Low HDL cholesterol	0.0244014***
High cholesterol	2.1991E-22***
Liquor consumption	0.0467339*
More than 50 years old	0.0797277*
Smoking	7.439E-25***
High blood glucose level	6.2782E-26***
More than 8 years of work	0.6188118
Diabetes	0.08022232*

*, *** Significant values

Chi-square test: The p-values of the chi-square test are recorded in Table 4 which shows that with the exception of seniority, all risk factors are associated with hypertension (p<0.1).

The most important relationships with hypertension are established with high triglycerides, overweight, high cholesterol, tobacco consumption and high blood sugar level for which a highly significant relationship is observed (p<0.01) while for liquor consumption, age and diabetes a significant relationship is observed (p<0.1).

Next, the mosaic charts between hypertension and the different risk factors considered are observed, to observe the sense of the relationships found in the test.

According to Fig. 2 and 3a, b, it is observed that hypertensive workers tend to have high cholesterol and do not have high levels of HDL cholesterol while that the distribution of employees shows that hypertensive people are characterized to consume cigarette and liquor.

Figure 4 shows that most diabetic or high sugar workers have hypertension problems. The results for the distribution of workers in Fig. 5 indicate that those who present problems of hypertension, present problems mostly of overweight and high triglycerides.

With regard age and seniority, it is observed in Fig. 6 that people over 50 years of age are characterized
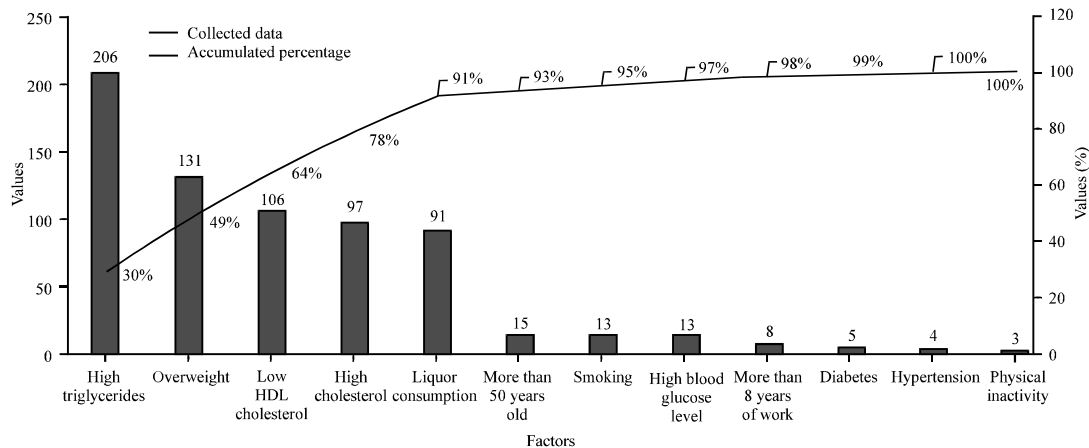
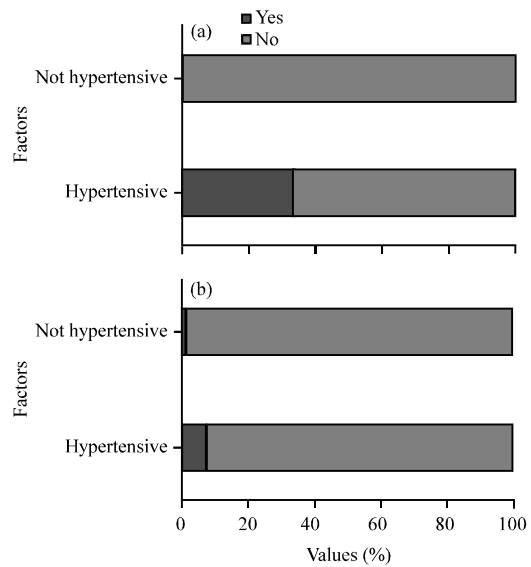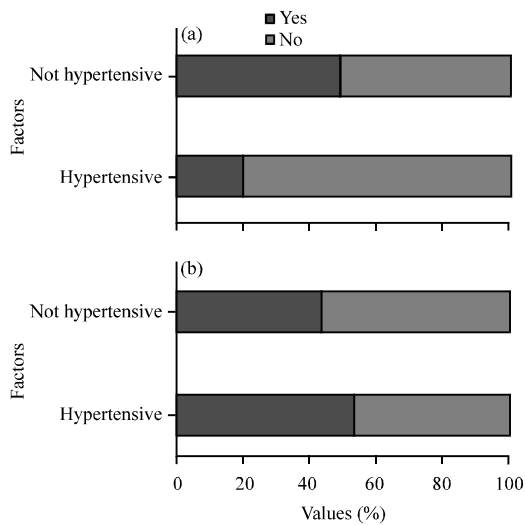Fig. 1: Pareto diagram for risk factors in miners.

Fig. 2: Mosaic plot between hypertension and factors associated with cholesterol; a) Low HDL cholesterol and b) High cholesterol

Fig. 3: Mosaic plot between hypertension and factors associated with cholesterol; a) Smoking and b) Consumption of liquor

by hypertension problems while workers with more than 8 years of work do not have hypertension problems.

The average age is 36.1 years old, this result is in accordance with what DANE affirmed which states that people who are between 22 and 55 years old, constitute, on average, 51.7% of the population of working age (15). In the study, conducted in miners in Boyaca (Colombia) (xx), similar results are found with an average age of 35.07 years (SD = 11.75). From the fifth or sixth decades of life, arterial hypertension obeys to causes different from those of the young adult. In this situation, the systolic blood pressure increases (>140 mmHg) and the diastolic pressure is maintained or decreased (<90 mmHg), increasing the differential pressure. One of the causes is

the rigidity of the arteries of conductance due to atherosclerosis and the action of some hormones such as: adrenaline, noradrenaline, angiotensin II and aldosterone on the medial arterial wall (Khodabandeh-Shahraki and Azizzadeh-Forouzi, 2012).

The results show a low prevalence of hypertension in the working population of mining contractor companies, with respect to national values, however, a possible bias of a healthy worker must be taken into account, since the criteria for hiring avoid selecting people with pathologies that may be aggravated by work. In studies in working population show prevalences of 29% (Prevalence of classic cardiovascular risk factors in a Mediterranean labor population of 4, 996 men). Serrano *et al.* (1999)
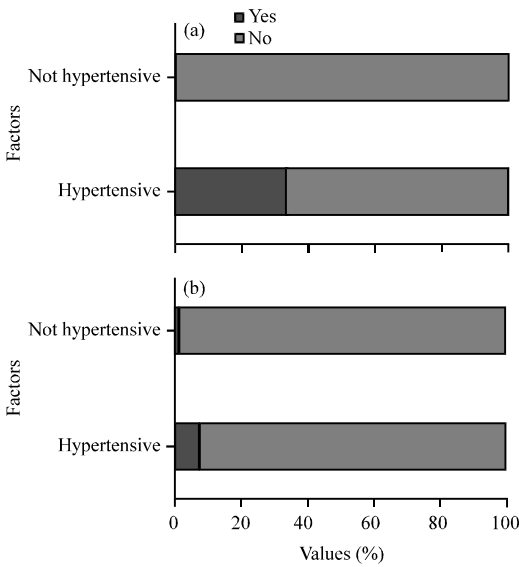
Fig. 4: Mosaic plot between hypertension and factors associated with cholesterol; a) High blood sugar and b) Diabetes
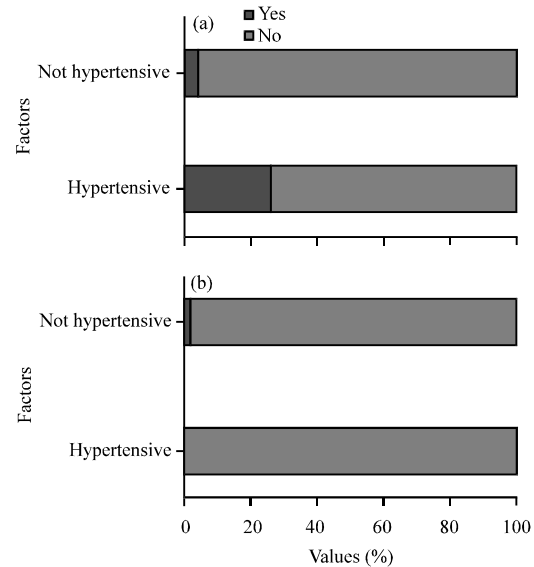

Fig. 6: Mosaic plot between hypertension and factors associated with cholesterol; a) More than 50 years old and b) More than 8 years of seniority
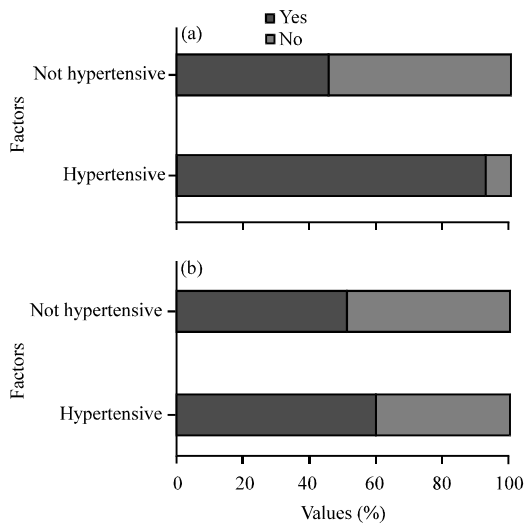

Fig. 5: Mosaic plot between hypertension and factors associated with cholesterol; a) High triglycerides and b) Overweight

in this study shows a prevalence of 7.5% taking into account that they are treated of show different and different population characteristics.

In a study done in Spain (51), it was observed that the consumption of snuff is 27.1% information compared to the population of this research is high, with respect to overweight represents 25.5% and obesity 9, 2% in our coal mining complex is 80 and 13%, respectively; 2.4% of professionals are sedentary compared to 100% of workers who refused to perform physical activity. In this Spanish

study the behavior of Diabetes Mellitus (DM) was 2.2% similar to that of the population under study with 1.5% and hypercholesterolemia with 17.9% but in the mining population was much higher with 44%, arterial hypertension was 9% and in research in miners it was 7.5%.

According to the World Health Organization (WHO), high blood pressure is the leading cause of death in the world with an average prevalence of 25% with a total of one billion hypertensives, a figure that will increase by 20 years in more than 50%. In Latin America the population under control is close to 12%, it is observed that this population manages figures below these behaviors, however, it may be due to the bias of a healthy worker, since, the criteria for hiring personnel do not usually select a workers with pathologies that could be worsened by work (13). However, it is evident that approximately half of the population has alterations in their body mass index, dyslipidemias and 100% of workers do not perform physical activity (taking into account their definition) which shows that these risk factors are present in levels of immediate intervention as well as the level of cardiovascular risk of the population whose highest percentage is between moderate and high which from the public health forces to strengthen the promotion of health and prevention of cardiovascular disease.

In 2009, studies in Cundinamarca to determine the prevalence of hypertension in personnel attending a PHI, it was found that 57% of the population had some

dyslipidemia, behavior that is similar to that presented by study workers (39). The levels of glycemia showed a low proportion of alterations, however, it is considered that having taken glycosylated hemoglobin would have been a more reliable variable to determine metabolic alterations related to blood sugar. It highlights the high overweight figures 50.2% of the population, however, it is appropriate to remember that the BMI does not specifically measure fat but that it expresses overall body weight per unit area. A man who is therefore, muscular will be labeled overweight even though his organic and functional conditions could be optimal. If the average BMI of 27.3 is compared with that obtained in this investigation with that of the study of prevalence of the classic cardiovascular risk factors in a Mediterranean labor population of 4, 996 men, it is observed that his BMI was 26.8, this value higher than 25 kg/m^2, point above which the presence of overweight is indicated and is similar found in the working population of this study. In a study carried out in 1987 on 349 mining workers in Riotinto, a BMI of 25.9 was found, however, after 5 years of follow-up it had become 26.2(12); Figure that was lower than that found in this study (12).

Some of the clinico-epidemiological relationships defined between obesity and HT can be summarized as follows.

Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) increase in relation to BMI. The prevalence of HBP is between 0.5 and 3 times higher among obese people (42). The incidence of hypertension and left ventricular hypertrophy is between 3 and 10 times higher in obese patients when compared with subjects with normal weight (42). Cardiovascular risk increases along with being overweight and it has been demonstrated that the risk is 50% higher for those who are overweight, 200% for those who have type I obesity and up to 300% or more for type II obesity, relationship with those who have a normal BMI (42).

The results of the proportions of tobacco and alcohol consumption can be influenced by the programs to discourage their consumption and with the sanctioning policies of the organization.

The prevalence of hypertension is higher in people with the following habits: smoking: 22.86%, alcoholism: 20.83%, consumption of additional salt at meals: 25.93% (7).

Physical activity, at least 30 min per session is denied by all workers which allows generating several research topics for future studies such as whether this would be related to the high proportion of dyslipidemias or if this could also be related with the appearance of musculoskeletal disorders.

In the country, the National Health Survey of 2007 and the National Survey of the Nutritional Situation in Colombia (2010) showed prevalences of sedentary lifestyle of 70% in men (43).

It is important to highlight that these workers perform physical activity inherent in their work activities but we must discard the hypothesis that their energy expenditure may be less than the caloric intake of their consumption patterns, influencing this in their body mass index, on the other hand, their activities do not obey a cardiovascular demand but rather work that includes force when handling loads, sometimes forced postures and exposure to environments with ambient temperatures typical of the Guajira Region.

The classification of cardiovascular risk is the subject of great discussions among scientific societies where the application of different models for the classification of cardiovascular risk is debated (predictive models such as the Framingham scale) where aspects in the interpretation are questioned which may be underestimating the risk with more lax scales or it may be overestimating the risk with more rigorous scales (37).

Every predictive model has limitations when taking the results to another type of population because the sociocultural variables of each region must be taken into account as it happens with the predictive model of Framingham which is used in our country but evidently does not contemplate some variables that for our population may be important (37).

Comparing these results with other descriptive studies such as the one conducted in hypertensive patients who work in the Ministry of Basic Industry of Cuba, in the period from January-December 1995 with the objective of identifying the risk factors that favor the onset of high blood pressure; it was found that the most affected age group was between 50 and 59 years old with predominance of males. Hypertension was significantly related to obesity, smoking habit and sedentary lifestyle, allowing us to observe that the behavior of these factors maintains similar tendencies.

The frequencies that the present study shows with respect to the National Survey of the nutritional situation in Colombia are similar, since, a prevalence of overweight of 46% was evidenced. If we analyze the percentage of workers who are overweight in addition to untrained physical activity as a concomitant risk factor, we may be facing a serious health situation that warrants an effective intervention. In the study, performed on male workers in the Mediterranean working population it was found that 19% had a BMI>30 (12).

About 100% of hypertensive patients are between 1 and 3 years old which could be related to some psychosocial risk factor in this relatively new population, however, it should be taken into account that this population came from a different recruitment model that is to say, it is probable that its seniority to the exposure of the work is greater than that of its seniority in the company.

In a study carried out in 2013 in relation to cardiovascular risk with the time of seniority in the company, no statistically significant differences were found neither in the bivariate analysis nor in the multivariate, also for this investigation in miners, unlike the research of Castan-Fernandez and Gutierrez-Bedmar (2004) where the cardiovascular history increases with seniority in the company which could be related to the increase in age and consequently associated comorbidities (52) (53). The most relevant results of this study are in the high proportion of dyslipidemic, sedentary and moderate cardiovascular risk level which generates a warning voice for the strengthening of programs of healthy lifestyles that promote physical activity and consumption patterns healthy.

In the sociological study and the knowledge of the risk factors of cardiovascular diseases in the Colombian Caribbean Coast published in 2005, it was reported that 25.1% of the population studied had dyslipidemia (cholesterol and elevated triglycerides). For this working population, the trend of values would be above; indicating probably an alteration of dietary consumption patterns, however, this would be a hypothesis to rule out in future studies (xx). According to Anonymous (2007) hypertensive diseases together were the ninth cause of death in Colombia for 2009 and in 2010, the 8th cause of mortality. By 2005, one of the complications of this disease, hypertensive heart disease (changes in the heart secondary to high blood pressure) was the leading cause of years lost due to disability in the general population, particularly in the group of 30-69 years and the 5th in those older than 70 years (14). In turn, these results allow to mark future lines of research such as the relationship of overweight and obesity with the development of musculoskeletal disorders; likewise the relationship between dyslipidemia and consumption patterns and other socio-cultural factors in these populations of workers in the mining sector.

CONCLUSION

From the results presented, from their discussion and from the background of the literature exposed through the study, the following main conclusions can be obtained: there is a high prevalence of risk factors for cardiovascular disease among workers of the mining contractor company, factors that in most cases are modifiable but a low prevalence is observed for diseases such as hypertension and diabetes, this could be explained due to the bias of a healthy worker because these companies handle strict professions for the entry of personnel that will develop high-risk tasks. The cardiovascular risk found by the Framinghan scale demonstrates a moderate risk for almost half of the population which aims to strengthen programs of healthy lifestyles and follow-up of workers with the risk of developing chronic pathologies. The application of the Framingham Model allows us to continue working on the need to deepen models appropriate to our epidemiological, anthropometric and sociocultural reality.

REFERENCES

Aburto, N.J., A. Ziolkovska, L. Hooper, P. Elliott and F.P. Cappuccio *et al.*, 2013. Effect of lower sodium intake on health: Systematic review and meta-analyses. Bmj., 346: 1-20.

Anonymous, 2007. [National Survey of Public Health of Colombia (In Spanish)]. Ministry of Health and Social Protection Colombia, South America.

Bedoya, E.A., D.D. Sierra, C.A. Severiche and M.D.J. Meza, 2017. [Diagnosis of biosecurity in the health sector of the Department of Bolivar, Northern Colombia (In Spanish)]. Inf. Tecnol., 28: 225-232.

Berger, J.S., C.O. Jordan, D. Lloyd-Jones and R.S. Blumenthal, 2010. Screening for cardiovascular risk in asymptomatic patients. J. Am. Coll. Cardiol., 55: 1169-1177.

Boutayeb, A. and B.S. Boutayeb, 2005. The burden of non communicable diseases in developing countries. Int. J. Equity Health, Vol. 4. 10.1186/1475-9276-4-2

Castan, F.J. and M. Gutierrez-Bedmar, 2004. [Cardiovascular risk factors and type of activity in a working population (In Spamish)]. Seguridad Salud Trabajo, 29: 18-43.

Dobashi, A., K. Goda, M. Kobayashi, K. Sumiyama and H. Toyoizumi *et al.*, 2014. UEG week 2013 poster presentations. U. Eur. Gastroenterol. J., 1: A135-A587.

D'Agostino Sr, R.B., M.J. Pencina, J.M. Massaro and S. Coady, 2013. Cardiovascular disease risk assessment: Insights from Framingham. Global Heart, 8: 11-23.

Fatema, K., N.A. Zwar, A.H. Milton, L. Ali and B. Rahman, 2016. Prevalence of risk factors for cardiovascular diseases in Bangladesh: A systematic review and meta-analysis. PloS one, 11: e0160-e0180.

Ghorani-Azam, A., B. Riahi-Zanjani and M. Balali-Mood, 2016. Effects of air pollution on human health and practical measures for prevention in Iran. J. Res. Med. Sci., 2016: 21-65.

Hernandez-Rincon, E.H., F. Lamus-Lemus, C. Carratala-Munuera, D. Orozco-Beltran and C.L. Jaramillo-Hoyos *et al.*, 2017. Building community capacity in leadership for primary health care in Colombia. MEDICC Rev., 19: 65-70.

Kalkhoran, S., N.L. Benowitz and N.A. Rigotti, 2018. Prevention and treatment of tobacco use: JACC health promotion series. J. Am. Coll. Cardiol., 72: 1030-1045.

Khodabandeh-Shahraki, S. and M. Azizzadeh-Forouzi, 2012. Effects of gradual exposure to carbon dioxide gas on the blood pressure status of workers in coal mines of Kerman province, Iran. ARYA. Atherosclerosis, 8: 149-152.

Lavie, C.J., D. Laddu, R. Arena, F.B. Ortega and M.A. Alpert *et al.*, 2018. Healthy weight and obesity prevention: JACC Health promotion series. J. Am. Coll. Cardiol., 72: 1506-1531.

Lopez-Martinez, F., A. Schwarcz, E.R. Nunez-Valdez and V. Garcia-Diaz, 2018. Machine learning classification analysis for a hypertensive population as a function of several risk factors. Expert Syst. Appl., 110: 206-215.

Nahimana, M.R., A. Nyandwi, M.A. Muhimpundu, O. Olu and J.U. Condo *et al.*, 2018. A population-based national estimate of the prevalence and risk factors associated with hypertension in Rwanda: Implications for prevention and control. BMC. Publ. Health, 18: 1-2.

Patino-Villada, F.A., E.F. Arango-Velez, M.A. Quintero-Velasquez and M.M. Arenas-Sosa, 2011. [Cardiovascular risk factors in an urban population of Colombia (In Spanish)]. Rev. Salud Publ., 13: 433-445.

Schmidt, M.I., B.B. Duncan, G.A. e Silva, A.M. Menezes and C.A. Monteiro *et al.*, 2011. Chronic non-communicable diseases in Brazil: Burden and current challenges. Lancet, 377: 1949-1961.

Serrano, A.G., E.A. Ezquerr and P.J. Estelles, 1999. [Prevalence of classic cardiovascular risk factors in a mediterranean working population of 4,996 males (In Spanish)]. Rev. Esp. Cardiol., 52: 910-918.

Vos, T., A.A. Abajobir, K.H. Abate, C. Abbafati and K.M. Abbas *et al.*, 2017. Global, regional and national incidence, prevalence and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: A systematic analysis for the global burden of disease study 2016. Lancet, 390: 1211-1259.

Walther, D., I. Curjuric, J. Dratva, E. Schaffner and C. Quinto *et al.*, 2017. Hypertension, diabetes and lifestyle in the long-term-results from a swiss population-based cohort. Preventive Med., 97: 56-61.