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INFLUENCE OF ANTHROPOMETRIC, METABOLIC AND HEMODYNAMIC PARAMETERS ON FASTING BLOOD GLUCOSE LEVELS: A STUDY IN COMMUNITY HEALTH WORKERS

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ABSTRACT

Introducción: La diabetes mellitus tipo 2 es un trastorno metabólico y su principal consecuencia, la hiperglucemia crónica, tiene un impacto significativo en la morbilidad y mortalidad de sus pacientes. **Objetivo:** El estudio evaluó la influencia de los parámetros antropométricos, metabólicos y hemodinámicos en los niveles de glucosa en sangre en ayunas en los trabajadores de salud comunitarios (CHA). **Métodos:** Este es un estudio transversal, cuantitativo y analítico, realizado en 2018 en el municipio de Montes Claros, Minas Gerais, Brasil, cuya población objetivo eran los agentes de salud de la comunidad (CHA) en las 135 unidades de salud del municipio. La recolección de datos incluyó variables demográficas (sexo, edad, color de piel, estado civil y escolaridad), antropométricas (peso corporal, altura y circunferencia de cintura y cadera), hemodinámicas (presión arterial) y bioquímicas (colesterol, triglicéridos, lipoproteínas de baja densidad, lipoproteínas de alta densidad y glucosa). Los análisis de la asociación entre variables de factores de riesgo y glucosa en sangre en ayunas se realizaron mediante regresión lineal. **Resultados:** 593 CHA participaron en el estudio, 83,8% mujeres, con edades entre 19 y 68 años. Entre los CHA, el 8,9% (n = 51) presentó glucemia en ayunas ≥ 100 mg / dl. Las variables edad, índice de masa corporal, relación cintura / cadera, triglicéridos y presión arterial sistólica se asociaron con glucosa en sangre en ayunas. El modelo final explicó el 18,9% de la variabilidad de la glucosa en sangre en ayunas. **Conclusiones:** Los parámetros clínicos y metabólicos contribuyen a la determinación de los niveles de glucosa en sangre en ayunas.

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INTRODUCTION

Chronic non-communicable diseases represent the main causes of death in the world, accounting for about 72% of all deaths in Brazil. Among these, diabetes mellitus (DM), the world epidemic, is highlighted with an estimated global prevalence of 8% in population[1,2,3,4]. This disease is defined as a set of metabolic disorders characterized by persistent hyperglycemia, resulting from deficiency in action and/or secretion of the hormone insulin.

DM is related to several factors, including hereditary, behavioral and socioeconomic aspects. These factors contribute both to onset of the disease and to complications. The presence of obesity, family history of this disease, altered fasting blood glucose, physical inactivity, hypercaloric diets, dyslipidemia, history of gestational diabetes and systemic arterial hypertension are considered relevant predictors of DM[5,6]. Psychosocial stress is also considered an important risk factor for the development of DM[7]. The work environment and modern lifestyle can contribute to the emergence of type 2 diabetes mellitus, among other diseases[8].

A study that aimed to relate the work process with illness among health professionals identified stress as the main risk factor for the development of chronic diseases, followed by hypertension, obesity, physical inactivity, DM, smoking and food[9]. This may be a reality of workers in health sector, due to the demands for meeting goals and overload of functions. of community health agents (CHA). In Brazil CHA are public health professionals who make up the Family Health Strategy (FHS) working group and act as a link between the health team and the user[10]. The CHA develop activities of prevention, treatment, rehabilitation of pathologies and health promotion through individual or collective interventions in households or communities[11]. Considering the relationship between health-disease work, the specificities of the CHA work can harm their health[12]. In the work of community health agents, some difficulties exist regarding the lack of limits in their attributions; precarious conditions; excessive physical and psychological demands, obstacles in relationship with the community and teams; fragility in vocational training and bureaucratization[13,14]. Some aspects of the health of3d CHA can suffer negative influences from work and characterize unhealthy conditions to the health of this worker[15]. Previous studies have also shown that CHA do not adequately apply health promotion guidelines with regard to their own health behaviors. It is essential for health professionals to engage in healthy behaviors to reduce the risk of non-communicable diseases and promote well-being, and; increase the chances of providing preventive counseling to your patients[16]. The importance of knowing the health conditions of the CHA is highlighted, taking into account the peculiar nature of their work and the few studies carried out that directly assess the glycemic profile of this professional. This information can support the implementation of new strategies to improve the living and working conditions of CHA and support public health policies, which can have a positive impact on health, both for CHA and the population they care for[12]. In this study, the objective was to evaluate the influence of anthropometric, metabolic and hemodynamic parameters on fasting blood glucose levels in community health agents.

METHODOLOGY

This is a cross-sectional, quantitative and analytical study conducted in 2018, in the municipality of Montes Claros, MG, Brazil. This municipality has about 400,000 inhabitants, GINI index of 0.53 and coverage by the Family Health Strategy (FHS) of 100%. The target population of the research was composed of community health agents (CHA) who work in the 135 Family Health Strategy (FHS) teams in the municipality. In this study, all professionals from the municipality were invited to participate. The CHA with less than one month of work, CHA in deviation of function or work leave by any nature, in the condition of pregnant women and who did not present eight hours of fasting were excluded. A questionnaire was used to collect sociodemographic variables**:** gender (female/male), age (years), skin color (white/non-white), marital status (single, divorced or separated/married or stable union) and schooling (incomplete high school/complete high school/incomplete higher education/complete higher education). Anthropometric, hemodynamic and metabolic profile measurements of the CHA were performed. Anthropometric parameters evaluated were body weight, height, and waist and hip circumferences. All subjects were submitted to barefoot measurements and with light clothing. The weight was measured by a digital portable scale OMRON®, model HBF-514C, in anthropometric position, with the back facing the instrument and the head positioned on the Frankfurt plane and they weight distributed on both feet. The height was obtained based on AVANUTRI® portable stameter and the point of measurement was with a steel rod that went down to find the vertex and the result was computed at the end of the deep inspiration[17]. Based on weight and height data, Body Mass Index (BMI) was estimated using the Quetelet equation, weight quotient (in kilos) by the square of height (in meters). Waist circumference (WC) was measured using a flexible and inelastic measuring tape, with an accuracy of 0.1 cm, and it was measured half-distance between the last rib and the iliac crest, after a normal expiration. Hip circumference was measured in the extension of larger diameter passing through the gluteus maximus at the back and pubic symphysis[17]. The waist/hip ratio (WHR) was estimated based on the division of waist circumference measurement into centimeters by hip circumference in centimeters. The hemodynamic parameter was evaluated by blood pressure measurement using a sphygmomanometer and Premium® stethoscope. The measurement was performed with the individual in the sitting position after 10 minutes of rest, right arm supported, at the level of the heart, armband of the device placed 3 cm above the antecubital fossa, centralizing the rubber pouch over the humeral artery[18]. Metabolic parameters were evaluated from peripheral venous blood collection after eight-hour fasting, and included total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL-c), very low density lipoprotein (VLDL), high density lipoprotein (HDL-c) and glucose. Commercial kits were used to perform biochemical tests: Colesterol Liquiform Labtest®; Triglicérides Liquiform Labtest®; HDL LE Labtest®; Glicose GOD Labtest®. The LDL-cholesterol level was estimated by Friedewald's equation[19]. Data analysis and tabulation was performed using the statistical program Statistical Package for the Social Science (SPSS) version 21. Initially, descriptive analyses of the variables investigated were performed by their distributions of absolute and relative frequencies. The quantitative variables were described by their minimum and maximum values, as well as means and standard deviation. Linear regression models were applied to identify anthropometric, metabolic and hemodynamic parameters associated with fasting blood glucose levels. The methodology used in the multivariate analysis consisted of the initial inclusion of all significant variables in the bivariate analysis, and backward elimination (exclusion of those variables with no significant contribution to the model). All the factors associated with elevated blood pressure, considering a significance level less than 0.25, were initially included in the multivariate analysis. After obtaining the predictive variables for the final model, we investigated the occurrence of association. The normality of the dependent variable was tested with the Kolmogorov-Smirnov test, and the assumptions related to residuals of the models (normality and homogeneity of variances) were graphically verified. The existence of possible multicollinearity problems among independent variables was verified by the variance inflation factor (VIF). The project was submitted to the Research Ethics Committee on Human Beings of the Universidade Estadual de Montes Claros - Unimontes, with approval Opinion No. 2,425,756/2017. Written informed consent was obtained from all participants. There were no conflicts of interest.

RESULTS

A total of 577 CHA participated in this study, of which 83.8% were women, 96% completed the high school, 87.2% declared themselves non-white and 58.2% lived with a partner (Table I). Table II presents data from descriptive analysis of sociodemographic characteristics, anthropometric measurements and metabolic profile.

Table I. Description of community health agents regarding characteristics such sociodemographic, health history, lifestyle, occupational, anthropometric measurements and metabolic profile, Montes Claros, MG, Brazil

Variables	n	%
Sex		
Male	95	16.5
Female	482	83.5
Skin color		
White	74	12.8
Non-white	503	87.2
Marital status		
Single	198	34.3
Divorced/Separated	40	6.9
Married/Stable Union	339	58.8
Schooling		
Incomplete high school	18	3.1
Complete high school	306	53.0
Some higher education	110	19.1
Complete higher education	143	24.8

Table II. Descriptive measures of sociodemographic, anthropometric, hemodynamic and metabolic variables of community health agents. Montes Claros, MG, Brazil

	Min	Max	Mean	SD
Age	19.00	68.00	36.47	9.82
Weight (kg)	38.80	142.10	72.32	16.59
Height (cm)	140.50	188.50	163.22	8.30
Body mass index (BMI)	16.36	56.44	27.11	5.70
Waist circumference (cm)	62.00	135.00	84.72	11.63
Hip circumference (cm)	32.00	180.00	103.71	11.51
Waist-hip ratio	0.65	2.19	0.82	0.09
Systolic Blood Pressure	89.00	230.00	126.27	17.51
Diastolic Blood Pressure*	49.00	122.00	77.25	11.84
Fasting Blood Glucose	60.00	183.00	87.70	25.93
Total cholesterol	48.00	298.00	174.12	30.13
HDL cholesterol	33.00	66.00	49.68	6.45
LDL cholesterol	35.00	167.00	99.75	24.56
VLDL cholesterol	9.00	130.00	24.81	10.49
Triglycerides	44.00	485.00	139.93	70.13

Table III. Pearson Correlation Analysis of independent variables with fasting blood glucose. Montes Claros, MG, Brazil

	r	*p-value*
Age	0.186	<0.001
Weight (kg)	0.187	<0.001
Height (cm)	0.033	0.424
Body Mass Index	0.191	<0.001
Waist-hip ratio	0.255	<0.001
Systolic blood pressure value	0.209	<0.001
Diastolic blood pressure value	0.197	<0.001
Total cholesterol	0.178	<0.001
HDL cholesterol	-0.034	0.402
LDL cholesterol	0.132	0.001
VLDL cholesterol	0.231	<0.001
Triglycerides	0.212	<0.001

The CHA had a mean fasting blood glucose of 87.70 (± 25.93) mg/dL. Among the CHA, 51 (8.9%) had altered fasting blood glucose, with 42 (7.3%) ranging from 100 mg/dl to 125 mg/dL and the other 9 (1.6%) with higher values. It was observed that variables presenting significant correlation ($p< 0.05$) with fasting blood glucose did so positively, as shown in Table III. The Multiple Linear Regression analysis is presented in Table IV with the demonstration of each stage of insertion of independent variables and the contribution of each one of them to the model. Based on the final model it was observed that for every 1 year older, blood glucose increases by 0.192; with each 1-unit of increase in BMI, blood glucose increases by 0.378; with each increase in waist-to-hip ratio, blood glucose increases by 4,143 units; with each increase of 1 unit of triglycerides, blood glucose increases by 0.018; with each 1 mmHg increase in systolic blood pressure, blood glucose increases by 0.079 (Table IV). The coefficient of determination (R^2) shows that the final model explained 18.9% of the variability of fasting blood glucose. The assumptions recommended in linear Regression of linearity, homoscedasticity, multicollinearity, normality, and independence of the residues were observed.

DISCUSSION

The prevalence of altered fasting blood glucose for the studied group showed worrying values. Among the 577 CHA who participated in the study, approximately 10% had altered fasting blood glucose. High fasting blood glucose is currently a major and growing public health problem in Brazil. The Global Burden of Disease Project estimated that in the country the age-standardized rate for high fasting plasma glucose was 2448.85 (95% UI 2165.96-2778.69)/100,000 for males, and 1863.90 (95% UI 1648.18-2123.47)/100,000 for females, the overall burden being 64.4% and 43.8% respectively[20]. The ELSA-Brasil cohort suggest that at least a third of Brazilian adults will develop diabetes during their lifetime. Frequencies of intermediate hyperglycemia according to various criteria ranged from 16.1% to 52.6%. Diabetes or intermediate hyperglycemia was present in 79.1% of participants when using the most comprehensive definitions[21]. The values found in this study are significant, since hyperglycemia, besides being the main alteration found in Type 2 Diabetes Mellitus, in long term is related to chronic complications that lead to an important reduction in quality of life[22]. In a population-based study with workers in Brazil, an important and growing gradient of the prevalence of diabetes Mellitus was observed, which more than doubled between 1998 and 2008[23]. This pattern of increasing prevalence of chronic conditions in Brazil is expected, due to the epidemiological, demographic and nutritional transitions that the country has been experiencing over the past decades[24]. Occupational stress is considered a risk factor for diabetes mellitus. Stress has a correlation with increased blood glucose, due to the release of cortisol into the blood[8]. The health professional suffers physical and mental wear and tear, which can be a risk condition for diabetes mellitus. In a study with nursing workers in São Paulo, the prevalence of Diabetes Mellitus was 3%. Elements such as the reduced number of professionals, the excess of activities performed and the difficulties in defining the different roles can be associated with the stressful levels of these professionals[7]. Among the variables that correlated with the increase in glycemic indexes, age is a non-modifiable factor. This result suggests the role of aging in the development of changes in glycemic metabolism. The changes in body composition and the increase in insulin resistance, both common with advancing age, would be the main responsible for the dysregulation of physiological pathways, leading to a higher incidence of hyperglycemia and DM2[25].

Body mass index, a method used to establish body composition and the risk of developing comorbidities associated with obesity, was important for the identification of the overweight risk factor associated with the development of type 2 DM among individuals studied. In a research with nursing professionals from an institution specialized in reproductive health in Mexico City, it was verified that body mass index increases as the risk category of DM increases[26]. A historical cohort study of workers at a public hospital in Brazil observed an increasing increase in weight and BMI in three decades, which reflect the growth of overweight and obesity in the country[27]. In CHA in the southern region of Rio Grande do Sul, Brazil, the prevalence of overweight and obesity was high, 39.2% and 30.5%, respectively. This condition was associated with high blood pressure, diabetes, anxiety, physical inactivity and work in an urban area[28]. Based on the analysis of this study it was possible to observe that the mean BMI was estimated at 27.11 kg/m² (± 5.70), with minimum and maximum extremes of 16.36 and 56.44 kg/m², respectively. The mean BMI can be classified within the overweight category and this leads to a higher chance of developing type 2 DM[29]. There is an inversely proportional relationship between body adiposity and insulin sensitivity. Thus, obese individuals, especially those suffering from abdominal obesity, are more likely to develop insulin resistance[30]. The Hip and Waist Ratio (WHR), a measure that assesses abdominal obesity, in this study presented values ranging between 0.65 and 2.19 and estimated mean of 0.82 (± 0.09). The mean value was below what is considered as a limit for this relationship, which is 0.95, being positive for the analyzed group. In the analysis of WC, the estimated mean was 90.98 cm, and the limit to be considered moderate risk for cardiovascular diseases is 94 cm. The measurement of high WC is related to metabolic alterations typical of metabolic syndrome and, therefore, it also increases the risk of developing type 2 DM[31]. There is a direct relationship between weight gain, WC and disease development. Previous studies have shown that the obesity and/or abdominal fat accumulation are important risk factors associated with the development of type 2 DM[32,33]. In this study, the main disorder of lipid metabolism related to fasting blood glucose was the alteration of triglycerides. The CHA had a mean TG of 145.63 mg/dL (± 89.20). A study of the metabolic profile of nursing workers found that the highest triglyceride value (165 mg/dL) was present in the high-risk group of development of type 2 diabetes[26]. In employees of a public university 4.4% of them had diabetes and hypercholesterolemia simultaneously, and glycemic control is considered the main factor that interferes in lipid concentrations of individuals with diabetes[34].

Table IV. Multiple linear regression of fasting blood glucose in community health agents Montes Claros, MG, Brazil

Variable	Model 1		Model 2		Model 3		Model 4		Model 5	
	Estimated parameter (EP)	p-value	Estimated parameter (EP)	p-Value	Estimated parameter (EP)	p-Value	Estimated parameter (EP)	p-Value	Estimated parameter (EP)	p-Value
Intercept	71.614	<0.001	57.910	<0.001	56.264	<0.001	56.097	<0.001	49.450	<0.001
Age	0.354 (0.270)	<0.001	0.302 (0.231)	<0.001	0.240 (0.183)	<0.001	0.220 (0.168)	<0.001	0.192 (0.146)	<0.001
BMI			0.577 (0.255)	<0.001	0.477 (0.211)	<0.001	0.440 (0.194)	<0.001	0.378 (0.167)	<0.001
WHR					5.202 (0.180)	<0.001	4.461 (0.154)	<0.001	4.413 (0.143)	<0.001
Triglycerides							0.020 (0.135)	0.001	0.018 (0.128)	0.001
Systolic Blood Pressure									0.079 (0.106)	0.011
Model R (2)	0.073		0.136		0.164		0.180		0.189	
R^2 ajustado	0,071		0,133		0,159		0,175		0,182	

Evidence shows that hypertriglyceridemia is the most frequent disorder in diabetic patients. The presence of triglycerides > 150 mg/dL was a risk factor for inadequate diabetes control (OR:2.6; CI:1.1 -6.3)[35]. Supranormal triglyceride levels are a cause, but also a consequence, of altered glycemic values, and as such, denotes important atheogenic potential, considerably increasing the cardiovascular risk of individuals with this disorder[36]. Regarding blood pressure, it was observed that CHA had an average of 120 × 70 mmHg (± 170 × 110) and mean systolic blood pressure (SBP) of 126.27 mmHg (± 17.51), while 22.8% adult Brazilian population has an average ≥ 140/90 mmHg[37]. Although the most recent Brazilian guidelines for hypertension control consider values higher than these for SAH diagnosis, international reference considers as high blood pressure levels ≥ 120 × 80 mmHg, because it already has progressive risks of possible cardiovascular outcomes in the population[38]. Among the CHA participating in this study, SBP was positively associated with increased blood glucose. A previous study demonstrated the existence of a higher SBP in individuals with type 2 DM[26]. The coexistence of hypertension in diabetic patients significantly increases the probability of developing cardiovascular disease (CVD)[39,40].

This study presents some limitations. The absence of the second fasting blood glucose dosage limited the screening of type 2 DM among CHA. It is derived from a cross-sectional design, and it is not possible to conclude the existence of a causal association between fasting blood glucose and the associated factors mentioned here, feasible in longitudinal designs. It must be considered that the best regression model explained only 19% of the variance of fasting blood glucose. This result suggests the possibility of other unevaluated variables that may contribute to the determination of glycemia and the presence of a non-linear effect in the analysis of the association between the included predictors and blood glucose. Care is needed in extrapolating the results to the general population, considering that the CHAs in this study have health, occupational and lifestyle conditions that may not reflect the reality of the Brazilian population, but allow comparison with populations with similar characteristics. The present study is relevant because it is a research with the entire population of CHA in a municipality, characterized as a census. The current specific literature on the important class of CHA is still scarce and it lacks greater approaches. The study has the potential to contribute in the area of workers' health with regard to care in maintaining healthy life habits to prevent chronic diseases. It is in the interest of the entire population that studies in this area be carried out, therefore, maintaining good physical and mental health conditions of those who care for other people supports the effectiveness of the whole country's health service and spending less money and preventing human costs. Identifying risk factors and preventing diseases is more convenient than just diagnostic incurable and expensive chronic comorbidities for public coffers. Healthy workers can offer much more satisfactory services to the entire population served by the FHS compared to those who are ill. In an investigation to examine the lifestyle behaviors and health promotion practices of doctors, nurses and community health workers in Brazil, it was identified that a high proportion of these professionals reported not engaging in healthy lifestyle behaviors that affect chronic diseases, therefore, they may be less likely to encourage such behaviors in their patients[16].

The relationship between work characteristics and health is recognized, but further investigations and approaches with specific work groups are needed to identify occupational vulnerabilities. The Occupational Health Surveillance must be constant and capable of describing the health profile of the working class, considering the analysis of the health situation, the characterization of the work and the socioeconomic and environmental profile[27]. Ensuring the well-being of the CHA as professional results in a better Quality of Life, reflecting on the satisfactory performance of the work itself[12]. Therefore, considering the results obtained, researchers suggest the adoption of preventive actions based on the guidance of these professionals about their own health. And to this end, is necessary to create measures capable of raising awareness and sensitizing them in simple, accessible and important manners such: reducing the consumption of fats and sugars, implementing more fruits and vegetables in food, practicing physical exercises and relaxation during breaks in the work routine, in addition to organize a schedule that establishes deadlines and mandatory schedule of examinations and periodic preventive consultations. Priority must be given to the health care of ACS workers and to promote interventions for prevention and promotion in the workplace.

CONCLUSION

Considering the results of this study, it is possible to conclude that age, BMI, WHR, triglycerides and systolic blood pressure are directly associated with increases in fasting blood glucose, thus contributing to increased risk for type 2 DM. Educational measures that stimulate changes in lifestyle should be specially developed for the studied group.

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