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Self-reported type 2 diabetes *Mellitus* is associated with abdominal obesity and poor perception of health in shift workers

Diabetes Mellitus tipo 2 associada com obesidade abdominal e autopercepção de saúde em trabalhadores de turnos

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ABSTRACT

Objective

To investigate factors that are associated with type 2 diabetes *Mellitus* in shift workers of a slaughterhouse in Southern Brazil.

Methods

This cross-sectional study included 1,194 18- to 50-year-old workers of both sexes. The presence of type 2 diabetes *Mellitus* was self-reported and confirmed by the use of hypoglycemic drugs or insulin. The independent variables were sex, age, skin color, marital status, education level, family income, leisure time physical activity, smoking, and self-reported health and nutritional status (body mass index and waist circumference). Multivariate analysis was performed from an *a priori* conceptual model.

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Results

The prevalence of diabetes was 1.3% (95%CI=0.6-1.9). Type 2 diabetes *Mellitus* was associated with poor or regular self-reported health (OR)=3.72; 95%CI=1.28-10.78) and level II abdominal obesity ≥102 for men and ≥88 for women (OR=5.76; 95%CI=1.07-29.10).

Conclusion

The prevalence of type 2 diabetes *Mellitus* was low. Moreover, the study evidenced the importance of using waist circumference to surveil and screen for metabolic diseases, such as type 2 diabetes *Mellitus*, and to monitor the low quality of life in the study individuals given the poor self-perceived health of workers with the said disease.

Keywords: Diabetes *Mellitus*, Type 2. Obesity abdominal. Occupational health. Workers.

RESUMO

Objetivo

Investigar os fatores associados à diabetes Mellitus tipo 2 em trabalhadores de turnos de frigorífico de frango no sul do Brasil.

Métodos

Trata-se de um estudo transversal, com 1 194 trabalhadores de ambos os sexos, com idade entre 18 e 50 anos. A presença de diabetes Mellitus tipo 2 foi avaliada por meio de autorrelato e confirmada pelo uso de medicação hipoglicemiante ou insulina. As variáveis independentes foram: sexo, idade, cor da pele, situação conjugal, escolaridade, renda familiar, atividade física de lazer, tabagismo, autopercepção de saúde e estado nutricional (índice de massa corporal e circunferência da cintura). Conduziu-se a análise multivariada, a partir de um modelo conceitual a priori.

Resultados

A prevalência de diabetes foi de 1,3% (IC95%: 0,6-1,9). A diabetes Mellitus tipo 2 esteve associada à auto-percepção de saúde regular ou ruim (RO=3,72; IC 95% 1,28-10,78) e à obesidade abdominal nível II - ≥ 102 para homens e ≥88 para mulheres (RO=5,76 CI95%1,07-29,10).

Conclusão

Foi encontrada baixa prevalência de diabetes Mellitus tipo 2. Além disso, evidenciou-se a importância do uso da medida de circunferência da cintura na vigilância e rastreamento de doenças metabólicas, como é o caso da diabetes Mellitus tipo 2, bem como a vigilância da baixa qualidade de vida desses indivíduos, por meio da autopercepção de saúde ruim dos trabalhadores com a patologia em questão.

Palavras-chave: *Diabetes Mellitus tipo 2. Obesidade abdominal. Autopercepção de saúde. Trabalhadores.*

INTRODUCTION

Type 2 Diabetes *Mellitus* (DM2) is a metabolic disease characterized by the lack or ineffectiveness of insulin. Studies show that diabetes increases the risk of developing vascular diseases, such as myocardial infarction and stroke[1-4].

According to the International Diabetes Federation (IDF), there are 382 million diabetics in the world, exceeding, in 2012, the projections for 2030. Brazil ranks fourth country in the occurrence of diabetes, with a prevalence of 6.9%[5]. However, there are no nationwide estimates of DM2 prevalence in Brazil, only self-reported measures have been used in nationwide studies.

The etiology of DM2 is multifactorial. The causes associated with its occurrence include sociodemographic factors, such as age, skin color, education level, and income; behavioral factors, such as eating habits, tobacco use, and physical inactivity; and body adiposity[6-8]. In addition, the

workplace may function as an indirect contributing factor due to its characteristics, such as long working hours, stressing, insufficient occupational physical activity, and shift work[9,10]. The number of studies that investigated the occurrence of metabolic disorders in workers have increased[11-14].

Type 2 diabetes *Mellitus* symptoms can interfere on workers' quality of life and productivity, and this is an important occupational health aspect. This study investigated the factors associated with DM2 in shift workers of a poultry processing plant in southern of Brazil.

METHODS

A cross-sectional study was conducted with a representative sample of 1,194 shift workers aged 18-50 years. The subjects worked in the production line of a round-the-clock poultry processing plant in southern Brazil.

The sample size was calculated to assess the association between work shift and obesity[12] based on the following presuppositions: confidence level of 95%; statistical power of 80%; unexposed: exposed *ratio* of 1:2 and risk *ratio* of 1:30. Sample size was increased by 10% to compensate for possible losses or refusals, so 1,125 workers were needed. All workers (1,270) who resided in the municipality where the plant is located and two nearby municipalities, working in one of the three production sectors (cutting room, thermoprocessed foods, and evisceration) were considered eligible for the study. Pregnant workers and those on leave for more than 10 days during the study period were excluded. There were 76 losses and refusals, resulting in 1,194 workers who remained in the study.

Standardized, coded, and pretested questionnaires collected demographic, socioeconomic, behavioral, and outcome data. The presence of DM2 was assessed by the question: "Has any doctor ever told you that you have diabetes *Mellitus*?" An affirmative answer to this question was confirmed by the use of hypoglycemic drugs or insulin.

The study demographic and socioeconomic variables were sex (men/women), age (collected as a continuous variable sorted into three categories: 18-29 years, 30-39 years, and ≥40 years), skin color (self-reported by the interviewees and categorized as white or other), education level (collected as a continuous variable and categorized as ≤4 years, 5-10 years, and ≥11 years), and family income (total income of each family member in the last month and categorized as tertiles (low, medium, high). The study behavioral variables were leisure-time physical activity (physically active: ≥150 min/week and inactive: <150min/week)[15], smoking ("never smoked", "ex-smoker", and "smoker"), and self-rated health status (poor, regular, good, very good, and excellent), later categorized as good self-rated health (excellent, very good, and good) and regular/poor self-rated health (regular and poor).

The workers' nutritional status and abdominal obesity were investigated by anthropometry. Nutritional status was defined by body mass index (BMI=kg/m²) and categorized as normal weight (≤25.0 kg/m²), overweight (25.0-29.9 kg/m²), and obese (≥30.0 kg/m²). Weight was measured by the Fantasy Sunrise scale, digital model 2096PP (Toledo, *São Paulo*, Brazil) with capacity of 130 kg and accuracy of 100 g. Height was measured by a stadiometer (SECA Bodymater 208, Hamburg, Germany) with a measuring range of 0-200 cm and accurate to 01 mm.

Abdominal obesity was assessed measuring Waist Circumference (WC) at the midpoint between the lowest rib and iliac crest. The cut-off points were: appropriate (<94 cm and <80 cm for men and women, respectively), Level I (WC ≥94 cm to <102 cm for men and 80≥ to <88 cm for women), and Level II (≥102 cm and ≥88 cm for men and women, respectively)[16].

Data were doubly entered into the software Epi Data version 3.1 (Epi Data, Odense,

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Denmark). The statistical analysis was performed by the software Stata version 11.0 (Stata Corporation, College Station, Texas, United States). The crude and adjusted *odds ratios* and respective 95% confidence intervals (95%CI) were estimated by logistic regression. The prevalence of DM2 was estimated to be lower than 6%, allowing the use of logistic regression without overrating effect measures. For the adjusted analysis, a conceptual model of analysis was used in which the variables were grouped from the more distally to the more proximally related to type 2 diabetes *Mellitus*. Therefore, the first level included demographic and socioeconomic variables, the second level included behavioral variables, and the third level included anthropometric variables. Only variables with $p<0.20$ in the crude analysis were included in the adjusted analysis. Afterwards, the variables included in the adjusted analysis were controlled for all the other variables of the same level, and those that presented $p<0.20$ were maintained in the next level of analysis.

RESULTS

Among the 1,194 workers included in the study, most were females (65.1%), aged 18-29 years (54.9%), non-smokers (85.8%), and physically inactive (73.7%); most had white skin (83.8) and secondary education (48.0%); and most presented good self-rated health (83.3%). A total of 25.7% of the workers were overweight, and 9.4% were obese; 25.4% had abdominal obesity level I, and 23.0%, level II (Table 1).

The prevalence of DM2 in the sample was 1.30% (95%CI=0.6-1.9). Among the study risk factors, there was a higher prevalence of DM2 in physically active workers (2.30%; 95%CI=0.89,3.72) with regular/poor self-rated health (3.50%; 95CI%0.90,6.10), and higher BMI (2.68%; 95%CI=0.01,5.71) and waist circumference (2.91; 95%CI=0.91,4.91) (Table 1).

Table 2 shows the crude and adjusted *odds ratios*. After the adjustments, the variables that remained statistically associated were physical activity, self-rated health, and abdominal obesity. Workers with level II waist circumference (≥102 for men and ≥88 for women) were almost six times more likely to have DM2 than those with normal waist circumference (<94 cm for men and <80cm for women). Active workers and workers with regular/poor self-rated health were 3.7 times more likely to have DM2 than inactive workers or workers with good self-rated health.

DISCUSSION

The main finding of our study is the low prevalence of DM2 among workers, although it is strongly associated with abdominal obesity and poor or regular self-rated health, regardless of nutritional status.

The 1.3% prevalence of DM2 found among workers was lower than that found by a Brazilian nationally representative study (6.9%)[5], and similar to others found among workers of 1.2%[17] and 1.7%[18]. This result may be explained by the healthy worker bias, i.e., relatively healthy people are or remain employed, whereas those with health problems are unemployed, retired, and/or unable to work. It should be pointed out that the symptoms of DM2 (polyuria, blurred vision, and others) may undermine productivity in the workplace. Therefore, the occurrence of DM2 may be a limitation for certain types of work that demand physical strength and long working hours, such as work performed in a poultry processing plant. Workers in large companies are periodically examined, which favors the diagnosis and prevention of chronic Noncommunicable Diseases (NCD). Moreover, these companies also allow workers to have at least one meal in the factory's canteen, thus providing a balanced energy and nutrient supply in at least one meal a day. Finally, self-report measures may underestimate DM2 prevalence[19]. All these aspects may contribute to a lower prevalence of DM2 in the workers of our sample.

The practice of physical activity as a protective factor against DM2 is well documented

Table 1. Sample characteristics and prevalence of type 2 Diabetes *Mellitus* (DM2) according to sociodemographic, behavioral, and anthropometric characteristics of shift workers of a poultry processing plant in southern Brazil. (n=1,194).

Variable	Sample		DM2		95%CI	*p*-value*
	n	%	n	%		
Sex						0.222
Male	417	34.90	3	0.72	(0.01-1.53)	
Female	777	65.10	12	1.54	(0.67-2.41)	
Age						0.085
18 to 29 years	644	53.90	4	0.62	(0.01-1.23)	
30 to 39 years	319	26.70	7	2.19	(0.57-3.81)	
≥40 years	231	19.40	4	1.73	(0.03-3.40)	
Skin color						0.284
White	998	83.80	11	1.10	(0.45-1.75)	
Non-white	193	16.20	4	2.07	(0.04-4.10)	
Education level (years)						0.218
≤4 years	210	17.60	4	1.90	(0.01-3.80)	
5 to 10 years	410	34.40	6	1.46	(0.30-2.63)	
≥11 years	573	48.00	5	0.87	(0.01-1.63)	
Family income (tertile)						0.319
Low	405	34.30	4	0.99	(0.01-1.95)	
Average	388	32.40	4	1.05	(0.02-2.10)	
High	393	33.30	7	1.78	(0.47-3.10)	
Smoking status						0.072
Never smoked	1023	85.80	10	0.98	(0.37-1.58)	
Former smoker	110	9.20	3	2.73	(0.01-5.81)	
Smoker	60	5.00	2	3.33	(0.01-8.00)	
Physical activity						0.027
Physically inactive	760	63.70	5	0.66	(0.08-1.23)	
Physically active	434	36.40	10	2.30	(0.89-3.72)	
Self-perceived health						0.006
Good	994	83.30	8	0.80	(0.24-1.40)	
Regular/Poor	200	16.80	7	3.50	(0.90-6.10)	
Nutritional status (BMI)						0.036
Normal (≤24.9 kg/m^2)	775	64.90	6	0.77	(0.01-1.40)	
Overweight (25 to 29.9 kg/m^2)	307	25.70	6	1.95	(0.04-3.51)	
Obese (≥30 kg/m^2)	112	9.40	3	2.68	(0.01-5.71)	
*Waist circumference***						0.003
Normal	615	51.60	3	0.49	(0.01-1.04)	
Level I	303	25.40	4	1.32	(0.03-2.61)	
Level II	275	23.00	8	2.91	(0.91-4.91)	

Note: *Fisher's Exact Test for heterogeneity of proportions (categorical variables) and linear trend (ordinal variables); **Normal: ♀ <80cm and ♂ <94cm, Level I: ♀ ≤80 cm to <88 cm and ♂ ≤ 94 cm to <102 cm, Level II: ♀ ≥88 cm and ♂ ≥102 cm.
95%CI: 95% Confidence Interval; BMI: Body Mass Index.

in the literature[20-22]. A systematic review evaluated the evidence from ten prospective studies, including a total of 301,221 adults and 9,367 incident cases, and follow-ups ranging from four to 17 years. The review found that moderate physical activity protected against the risk of type 2 diabetes[20]. However, in our study, DM2 was associated with the practice of 150 minutes or more of physical activity per week. Our finding may probably be explained by reverse causality. Physically-active workers may have been physically inactive for almost all their lives but changed their

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Table 2. Crude and adjusted *Odds Ratios* (OR) and their respective Confidence Intervals (95%CI) for type 2 Diabetes *Mellitus* (DM2) according to sociodemographic, behavioral, and anthropometric characteristics of shift workers of a poultry processing plant in southern Brazil. (n=1,194).

Variable	Crude analysis		Adjusted analysis	
	OR (95%CI)	*p*-value*	OR (95%CI)	*p*-value*
*1º Level***				
Sex				
Male	1	0.234	-	
Female	2.16 (0.61-7.71)			
Age				
18 to 29 years	1	0.093	1	0.093
30 to 39 years	3.59 (1.04-12.35)		3.58 (1.04-12.35)	
≥40 years	2.82 (0.70-11.37)		2.82 (0.70-11.36)	
Skin color				
White	1	0.276		
Non-white	1.90 (0.60-6.03)		-	
Education level (years)				
≤4 years	2.21 (0.59-8.29)	0.223		
5 to 10 years	1.69 (0.51-5.57)		-	
≥11 years	1			
Family income (tertile)				
Low	1	0.323		
Average	1.06 (0.26-4.27)			
High	1.82 (0.53-6.26)		-	
*2º Level***				
Smoking status				
Never smoked	1	0.123	1	0.113
Former smoker	2.84 (0.77-10.48)		2.07 (0.53-7.98)	
Smoker	3.49 (0.75-16.31)		3.29 (0.70-16.29)	
Physical activity				
Physically inactive	1	0.021	1	0.024
Physically active	3.56 (1.21-10.49)		3.50 (1.16-10.48)	
Self-perceived health				
Good	1	0.004	1	0.014
Regular/Poor	4.47 (1.60-12.47)		3.72 (1.28-10.78)	
*3º Level***				
Nutritional status (BMI)				
Normal (≤24.9 kg/m^2)	1	0.042	1	0.726
Overweight (25 to 29.9 kg/m^2)	2.55 (0.82-7.98)		0.85 (0.20-3.53)	
Obese (≥30 kg/m^2)	3.53 (0.87-14.31)		0.78 (0.13-4.53)	
*Waist circumference****				
Normal	1	0.006	1	0.040
Level I	2.73 (0.61-12.27)		3.55 (0.68-14.15)	
Level II	6.11 (1.61-23.22)		5.76 (1.07-29.10)	

Note: *Logistic regression: Wald test to heterogeneous proportions (categorical variables) and linear trend (ordinal variables); **Adjusted for other variables of the same level and maintained at the next level of analysis when $p<0.20$; ***Normal: ♀ <80cm and ♂ <94cm; Level I: ♀ ≤80 cm to <88 cm and ♂ ≥94 cm to <102 cm; Level II: ♀ ≥88 cm and ♂ ≥102 cm. *p*-value for Hosmer-Lemeshow test=0.98.
95%CI: 95% Confidence Interval; BMI: Body Mass Index.

lifestyle when they were diagnosed with DM2 as healthcare professionals strongly recommend diabetics to exercise.

The workers who rated their health as regular/poor were more prone to having DM2 than those who rated their health as good. This

result is expected, since the presence of DM2 may cause many symptoms, such as thirst, polyuria, blurred vision, weight loss, and hyperphagia. In its most severe forms, it may cause ketoacidosis or nonketotic hyperosmolar syndrome, drastically diminishing the quality of life of the affected individuals[23,24]. These associations have already been observed in other studies[25,26].

Abdominal obesity was associated with DM2 regardless of workers' BMI. Metabolic complications associated with obesity were not only related to excess weight, but also, and mainly, to the distribution of body fat. In this sense, studies have shown that localized fat in the central region of the body, particularly visceral adiposity, has a greater influence on the development of NCD, such as DM2, as it is a reflection of a pathological state associated with metabolic diseases[27-30]. Waist circumference is the anthropometric measure most strongly correlated with the quantity of visceral adipose tissue[28-30]. Thus, occupational health professionals may incorporate waist circumference measurement in their routine evaluations as it is an important marker of cardiometabolic risk.

Some limitations of this study, such as reverse causality and the healthy worker bias, have already been discussed. Another possible limitation is the use of self-reported measures for measuring the outcome. However, self-reported measures of NCD have been widely used in prevalence studies. In Brazil[1] important nationally representative epidemiological studies, such as the *Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico* (VIGITEL, Telephone Survey on Chronic Noncommunicable Disease Protective and Risk Factors, *Brasília, Distrito Federal*, Brazil) and the *Programa Nacional por Amostra de Domicílio* (PNAD, National Household Sample Survey), have employed the same methodology[5,31]. It should also be highlighted that, based on the sample size (n=1,194), a 1.5% prevalence of DM2 could be observed, considering a confidence level of 95.0%, an acceptable error of 1 percentage point, and a statistical power of 80.0% to detect a prevalence *ratio* of 3.8 between DM2 and its associated factors. Finally, a conceptual model was used in adjusted analysis; however, the variables included in this model explained only 16.0% of the outcome (pseudo-R2=0.16).

CONCLUSION

The results of this study point to a greater prevalence of DM2 in workers with abdominal obesity, reinforcing it as an important predictive factor for this disease. In this sense, the efficiency and practicality of waist circumference as a screening measure for workers should be highlighted. In addition, most diabetic workers rated their health status as regular/poor, showing that the symptoms of DM2 decreases the quality of life of its carriers, which may result in loss of productivity in the work place and, therefore, exclusion from the labor market. Thus, in addition to preventive DM2 actions, workers who already have diabetes should receive special care in order to avoid the worsening of the disease, preserve their quality of life, and prevent exclusion from the labor market.

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CONTRIBUTORS

All authors participated in all phases of the research.

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