Nutritional Risk in the Urban Population of Ouro Preto, Southeastern Region of Brazil: The Ouro Preto Heart Study

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Summary

Objective: To estimate the prevalence of combined nutritional risk [body mass index (BMI) and waist circumference (WC)] according to sociodemographic and sedentarism characteristics of the urban population of Ouro Preto, state of Minas Gerais, Brazil.

Methods: This cross-sectional study was conducted with a probability sampling of 768 subjects aged 15 years or older. Nutritional risk (NR) was defined according to the BMI and WC classification criteria adopted by the National Institutes of Health. Isolated NR (INR) was defined as women with WC ≥ 80 cm and men with WC ≥ 94 cm, and the combined nutritional risk (CNR) as the same WC values mentioned above and/or BMI ≥ 25 kg/m². Binary logistic regression and the Hosmer & Lemeshow test were used to construct and adjust these models.

Results: INR was observed in several BMI categories for both women and men, with the following results: 19.1% and 1.4% among those with normal weight, 91.7% and 56% in overweight patients, and 98.5% and 80% in obese patients, respectively. Age and level of education were independently associated with the CNR. Odds ratios (OR) for CNR in women and men over 60 years of age were 9.94 and 14.35, respectively, when compared to younger patients. For women with ≤ 4 years of schooling, the OR was 1.83 compared to patients with more than 4 years of school attendance, while among men with an average number of years of school attendance, the OR was 2.55 relative to those with more years of schooling.

Conclusion: These findings show that age and education have an independent effect on the probability of CNR occurrence, and also that a joint analysis of BMI and WC is important in screening groups for nutritional risk.

Key words: Overweight; obesity; body mass index; abdominal circumference; prevalence.

Introduction

Obesity is a chronic multifactor disease characterized by excess adipose body tissue. It has been simultaneously cited as an important risk factor for increased mortality and the onset of non-transmissible chronic diseases[1,2]. Several studies have documented the relevance of anthropometric indicators for diagnosing obesity and assessing the nutritional risk for comorbidities[2-4].

In epidemiological studies, body mass index (BMI) is the indicator most commonly used due to its good correlation with total body fat, easy applicability, and low-cost[5]. However, this index has clear limitations when it comes to defining overweight/obesity according to the different categories of gender, age, race, and physical activity, and evaluating the nutritional risk for comorbidity[3,6,7], as well as differentiating and quantifying body fat distribution[5,8].

Diabetes, arterial hypertension, and metabolic syndrome are risks known to be associated with the distribution of body fat and, more specifically, the increase of central fat[2,3,9,10]. The most commonly used method to evaluate central obesity has been the waist circumference (WC) measurement due to its good correlation with visceral fat[3,11,12]. Some authors have shown that in normal-weight, overweight, and grade-I obesity individuals, as defined by their BMI, the nutritional risk for the occurrence of non-transmissible comorbidities may be underestimated when there is an increased WC[3,7,12].

Recently, the combined use of BMI and WC has been proposed for assessing the nutritional risk in a given population[3,7,9,13,14], considering that this procedure increases the accuracy of the diagnosis. However, it should be noted that the nutritional risk might vary according to social, economic, demographic, and behavioral characteristics of different population groups[15,16]. All this considered, this study had the goal of estimating the prevalence of the combined nutritional risk [body mass index (BMI) and waist circumference (WC)] of the urban population of Ouro Preto, state of Minas Gerais, southeastern Brazil, according to their sociodemographic and sedentarism characteristics.

Methods

Study population - This study was conducted in 2001,

Original Article

with a population aged 15 years or older living in private homes of the city of Ouro Preto, Minas Gerais, totaling 25,222 individuals.

Study design and sample - This is an epidemiological sectional-type study designed to estimate the prevalence of risk factors for cardiovascular diseases in this population. The sample consisted of 929 households and was calculated using an estimated prevalence of systemic arterial hypertension of 25%[17], a desirable accuracy of 3%, a significance level of 95%, and an estimated loss of 20%. Households were selected from the list of addresses distributed over 33 census districts, and according to household density by district as defined by the Instituto Brasileiro de Geografia e Estatística (IBGE) (Brazilian Institute of Geography and Statistics)[18]. From each sample household, one individual aged 15 years or older whose date of birth was closest to the interview date was selected. If the chosen individual did not wish to take part of the study, that household was eliminated and replaced by the next house to its right. Collective or commercial buildings, or those whose residents did not wish to participate, were substituted by the next house to their right.

Data collection - Individuals interviewed were scheduled to undergo clinical and anthropometric examinations from 7:00 am to 10:00 am after a 12-hour fast. Participants were weighed on a TANITA BF 542™ scale (maximum weight 136 kg with a 0.2 kg variation), calibrated for each measurement, with subjects wearing light clothing, no jewelry and/or costume jewelry, having an empty bladder and after having fasted for 12 hours.

Participants' height was measured according to Frisancho's[19] method using a field anthropometer. The criterion for the classification of body mass index (BMI) of adults and elderly people was that established by the World Health Organization and adapted by the National Institutes of Health (NIH)[20]. According to this criterion, individuals with BMI < 18.5 kg/m^2 are underweight, those from 18.5 to 24.9 are normal-weight, $\geq$ 25 to 29.9 kg/m^2 are overweight, and people $\geq$ 30 kg/m^2 are obese. For adolescents, the international Cole et al.[21] standard was used, which classifies teenagers with BMI < 5th percentile as underweight, between $\geq$ 85th to < 95th percentile

as overweight, and in the $\geq$ 95th percentile as obese.

Waist circumference (WC) was measured at the midway point between the coastal margin and iliac crest, or natural waist, with the patient in the supine position. Women with values $\geq$ 80 to < 88 cm and men with $\geq$ 94 to < 102 cm were classified as having excess central fat (central overweight), therefore bearing a moderate isolated nutritional risk (INR) for non-transmissible morbidities. Women with WC values $\geq$ 88 and men with $\geq$ 102 cm were classified as having central obesity, or a high INR according to the criteria proposed by Lean et al [22]. The term INR was adopted in order to check for the presence of risk in the different BMI categories.

WC and BMI classification criteria were used to define the combined nutritional risk (CNR). Subjects were classified as being 'no-risk' when they had normal WC measurements (WC < 80 for women and < 94 cm for men) and underweight or normal BMI (BMI < 25 kg/m^2 or below the 85th percentile [adolescents]). Subjects at risk were those with INR (WC $\geq$ 80 cm for women and WC $\geq$94 cm for men) regardless of the BMI category, and also those considered overweight or obese as per their BMI, for the definition of the final explanatory model using multivariate logistics.

Sociodemographic and sedentarism data were obtained by direct personal interviews using a structured and pre-coded questionnaire. Educational level was classified as low (from illiterate to incomplete primary education), middle (complete primary education to incomplete secondary education), and high (complete secondary education to higher education). The socioeconomic class was defined by criteria proposed by the Associação Nacional de Pesquisa[23] according to the number of consumer goods, domestic aid, number of bathrooms in the house, and level of education of the head of the family. Socioeconomic classes were grouped as A and B (high and middle), C (middle-low), D and E (low and very low). Occupational activity was categorized as light (activities easily performed or that can be performed seated, e.g., secretarial work), moderate (work that required walking and sitting, e.g., stock keeping work), or heavy (heavy work, such as civil construction work). In this study, sedentarism was defined as the combination of occupational activity and duration of

Gender	Age group (years)	IBGE	%	Sample	%	Weight
Male	15 a 19	2,932	7.21	41	4.33	1.6329
	20 a 39	9,276	22.80	111	12.01	1.9082
	40 a 59	5,390	13.24	86	9.31	1.4311
	60 ou +	1,870	4.59	41	4.44	1.0415
Female	15 a 19	2,870	7.05	45	4.76	1.4563
	20 a 39	9,763	24.00	242	25.87	0.9212
	40 a 59	5,816	14.30	229	24.78	0.5799
	60 ou +	2,767	6.80	134	14.50	0.4715
Total		40,684	100.00	929	100.00	

Table 1 - Distribution of IBGE's population count (2000) and that of the sample (2001), as per gender and age group, in the city of Ouro Preto

Freitas et al
NUTRITIONAL RISK IN THE URBAN POPULATION OF OURO PRETO, SOUTHEASTERN REGION OF BRAZIL: THE OURO PRETO HEART STUDY

Original Article

physical activity during leisure time[24,25]. Those who had a light or moderate occupational activity, such as students, office clerks, teachers, among others, and less than 150 minutes of physical activity per week during their leisure time, were classified as sedentary.

Statistical analysis - The analysis was weighted[26] by gender and age, and the weights were determined by the ratio between the proportions of individuals in the IBGE and in the sample (Table 1). Pearson's chi-square test (χ^2) was used to compare the proportions of individuals in the sample and estimated by IBGE, and compare subjects with a CNR according to sociodemographic variables and sedentarism. Variance analysis was used to compare the anthropometric measurement means, and Student's minimum significant difference test was used to compare paired groups. Binary logistic regression and the Hosmer & Lemeshow's test were utilized to construct and verify the adjustment of the models of factors independently associated with the combined nutritional risk (WC and BMI). A $p \leq 0.20$ value and epidemiological and biological plausibility were the criteria used for the inclusion of variables in the multivariate model.

A $p \leq 0.05$ value was adopted as a statistically significant level for defining the final model.

The project was approved by the Universidade Federal de Ouro Preto Research Ethics Committee, under the number 2001/26.

Results

Comparing the characteristics of the study sample with information about the population estimated by IBGE in the city, a significantly larger proportion (70%) of women over men and adults (71.9%) over young people was observed. The sample was then weighted by gender and age and consisted of 768 individuals, 50.8% women and 49.2% men; 16.5% of the participants were between 15 and 19 years of age, 45.3% between 20 to 39 years of age, 27.2% between 40 and 59 years of age, and 10.9% were 60 years or older. Refusals to continue participating in the second phase of the study when clinical and anthropometric examinations were being performed, after three systematic invitations, totaled 17.2%.

Table 2, stratified by gender, displays means and

Characteristics	Female			Male		
	n	BMI (kg/m²)	WC (cm)	n	BMI (kg/m²)	WC (cm)
		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD
Age						
15-19 years	59	22.7 (3.6)[a]	73.5 (8.3)[a]	68	21.9 (4.4)[a]	76.0 (10.6)[a]
20-39 years	173	24.7 (5.9)[b]	79.7 (12.9)[b]	175	23.2 (3.9)[b]	80.7 (10.6)[b]
40-59 years	112	27.4 (5.8)[c]	87.3 (13.8)[c]	97	24.8 (3.6)[c]	89.2 (11.3)[c]
≥ 60 years	46	27.9 (5.0)[c]	92.9 (13.5)[d]	38	25.1 (3.5)[c]	90.6 (11.4)[c]
P value[+]		<0.01	<0.01		<0.01	<0.01
Class #						
D/E	187	25.7 (6.1)	83.2 (1 4.0)	149	23.0 (3.6)	80.9 (10.7)[a]
C	154	25.4 (5.6)	82.3 (14.3)	160	24.0 (4.5)	83.8 (12.7)[b]
A/B	48	25.4 (4.7)	80.5 (12.9)	68	23.6 (3.7)	85.6 (12.7)[b]
P value[+]		0.83	0.47		0.09	0.02
Schooling&						
Low	196	26.9 (6.2)[a]	86.1 (14.0)[a]	159	24.1 (3.6)	84.8 (11.5)
Middle	77	23.7 (5.2)[b]	77.1(13.4)[b]	101	23.3 (4.1)	80.2 (11.3)
High	115	24.6 (4.7)[b]	80.2 (12.7)[b]	116	23.0 (4.4)	82.9 (13.0)
P value[+]		<0.01	<0.01		0.06	0.10
Sedentarism						
Yes	305	25.6 (6.1)	81.4 (12.5)	202	23.6 (3.8)	83.6 (11.1)
No	84	25.2 (4.4)	82.8 (14.3)	170	23.6 (4.4)	82.5 (13.1)
P value[+]		0.49	0.39		0.98	0.38

#Socioeconomic class: A/B: high-middle, C: middle-low, D/E: low-very low. &Schooling: Low: illiterate to incomplete primary level; Middle: complete primary to incomplete secondary level; High: complete secondary level to higher education.
+P value (ANOVA) as per sociodemographic and gender characteristics.
a,b,c,d: the same letters indicate similarity of means among the strata of the same indicator.

Table 2 - Means and standard deviations of nutritional indexes, weighted for gender/age, according to sociodemographic characteristics and gender, in the urban population of Ouro Preto

Original Article

standard deviations of the anthropometric indicators by sociodemographic and sedentarism characteristics. In summary, BMI and WC means in women varied significantly according to age and level of education, and the variation was more significant among women 60 years of age or older and with lower levels of schooling. No significant differences as to socioeconomic class and sedentarism were observed. Among men, the mean BMI varied according to age; however, the mean WC increased significantly with age and according to socioeconomic class improvement.

Table 3 displays the nutritional profile, from BMI and WC classifications according to social, demographic, and sedentarism characteristics. A significant variation of the nutritional profile according to gender, age, schooling, and sedentarism was observed.

Using BMI, the overall prevalence observed of underweight was 6.4% (n=49), overweight was 30% (n=230), and obesity was 11.9% (n= 92). Overweight and obesity were more

frequent among women, 31% and 17.2%, respectively, among participants $\geq$ 60 years of age (43.5% and 18.8%), and among those with less years of schooling (35.8% and 15.2%).

As to the overall prevalence of central overweight, 19.1% (n= 146) of the participants met this criterion, as well as 19.4% (n= 149) for central obesity; among women, central overweight was present in 21.9% and central obesity in 32.4%, whereas in men it occurred in 16.4% e 6.1%, respectively. These two indicators were also greater in those aged $\geq$ 60 years (29.8% and 40.5%) and in those classified as sedentary (20.3% e 21.5%). As to the educational levels, approximately 50% of the individuals with little schooling presented a prevalence of central overweight or central obesity, whereas it was 40% among high-class individuals.

Concerning the frequency of the isolated nutritional risk associated with different BMI and WC categories (Table 4), individuals at nutritional risk due to WC values were found in all BMI classifications. That is, even though classified as people with

	BMI (kg/m²)									WC (cm)***							
	UW		N		OW		OB		p+	N		COW		CO		p+
	n	%	n	%	n	%	n	%		n	%	N	%	n	%	
% Total*		6.4		51.7		30.0		11.9			61.5		19.1		19.4	
Gender																
Female	25	6.4	177	45.4	121	31.0	67	17.2	<.01	178	45.8	85	21.9	126	32.4	<.01
Male	24	6.4	219	58.1	109	28.9	25	6.6		294	77.6	62	16.4	23	6.1	
Age																
15-19 years	14	11.0	90	70.9	17	13.4	6	4.7		112	87.5	11	8.6	5	3.9	
20- 39 years	24	6.9	198	56.9	96	27.6	30	8.6	<.01	239	68.7	66	19.0	43	12.4	<.01
40- 59 years	7	3.4	81	38.9	81	38.9	39	18.8		96	45.9	45	21.5	68	32.5	
$\geq$ 60 years	4	4.7	28	32.9	37	43.5	16	18.8		25	29.8	25	29.8	34	40.5	
Schooling&																
Low	16	4.5	158	44.5	127	35.8	54	15.2		176	49.6	89	25.1	90	25.4	
Média	17	9.6	105	59.0	37	20.8	19	10.7	<.01	137	77.0	21	11.8	20	13.4	<.01
High	16	6.9	131	56.5	66	28.4	19	8.2		158	68.4	34	14.7	39	26.2	
Class#																
D/E	19	5.7	180	53.6	98	29.2	39	11.6		203	60.6	64	19.1	68	20.3	
C	23	7.3	156	49.5	91	28.9	45	14.3	0.34	197	62.7	55	17.5	62	19.7	0.74
A/B	8	6.8	59	50.4	42	35.9	8	6.8		71	61.2	26	22.4	19	16.4	
Sedentarism																
Yes	30	5.9	258	50.9	147	29.0	72	14.2	0.05	296	58.3	103	20.3	109	21.5	0.04
No	19	7.5	135	52.9	82	32.2	19	7.5		173	67.8	42	16.5	40	15.7	

* n varies due to unknown data.
** BMI: UW (underweight) N (Normal); OW (Overweight); O (Obesity).
*** WC: N (normal); COW (central overweight); CO (central obesity).
# Socioeconomic class: A/B: high to middle, C: low middle, D/E: low to very low.
&Level of schooling: Low: from illiterate to incomplete primary; Middle: complete primary to incomplete secondary, High: complete secondary to higher education.
+P value (χ2 Pearson): proportion comparison between strata of the same indicator.

Table 3 - Nutritional profile as per classification of the body mass index [BMI] (kg/m²) and waist circumference [WC] (cm), according to sociodemographic characteristics

Freitas et al
NUTRITIONAL RISK IN THE URBAN POPULATION OF OURO PRETO, SOUTHEASTERN REGION OF BRAZIL: THE OURO PRETO HEART STUDY

Original Article

BMI categories	Risk category (WC)*					
	Low		Increased		High	
	n	%	n	%	n	%
Female						
Low weight (n=25)	24	96.0	-	-	1	4.0
Normal weight (n=178)	144	80.9	30	16.9	4	2.2
Overweight (n=121)	10	8.3	53	43.8	58	47.9
Obesity (n=66)	1	1.5	1	1.5	64	97.0
Male						
Low weight (n=24)	24	100	-	-	-	-
Normal weight (n=219)	216	98.6	2	0.9	1	0.5
Overweight (n=109)	48	44.0	52	47.7	9	8.3
Obesity (n=25)	5	20.0	7	28.0	13	52.0

Low risk: WC <80 cm (women) and <94 cm (men); increased risk: WC ³ 80 cm to < 88 cm (women) and ≥ 94 to < 102 cm (men) and high risk: CC ≥ 88 cm (women) and ≥ 102 cm (men).

Table 4 - Frequency distribution of nutritional risk associated with different categories of BMI (kg/m²) and WC (cm), according to gender

normal BMI, mean values of participants' WC measurements were above normal: 19.1% for women and 1.4% for men. As to overweight BMI, the percentage of high risk (central obesity) was 47.9% for women and 8.3% for men. Most women in this group classified as obese, according to the BMI, had central obesity (97%) due to their WC, whereas among men this percentage was 52%. In the underweight category according to the BMI, only one woman with a high nutritional risk was found, that is, she was obese; no men fit the INR category.

Table 5 displays the prevalence of combined nutritional risks (BMI and WC). Men and women presented a significant rise in this risk indicator with age, and a drop with higher levels of schooling. Among patients ≥60 years of age or older, the prevalence of CNR was 84.8% for women and 63.2% for men, and 70.6% and 43.4% for women and men, respectively, with lower educational levels. It is worth mentioning that among women, a significant difference (p< 0.01) was observed in all schooling categories, whereas among men with middle and high education levels, the CNRs were similar (p = 0.53).

The lack of physical activity was not significantly related to CNR in both genders, as well as socioeconomic class categories among women (p>0.20).

Table 6 displays bivariate and multivariate analyses. Combined nutritional risk was significantly associated with age and education in both genders, and with the socioeconomic class among men. The CNR increased with age in both genders, with more marked magnitudes among men when compared to women. As to schooling, a different behavior was observed for each gender. At the time of construction of the multivariate models, it was decided that two classification categories of schooling would be used for women. Women with ≤ 4 years of schooling had a greater CNR when compared to those with a higher level of education, whereas in men this index was significant among those in the middle range of years of schooling in comparison with those with higher education levels.

A trend towards a lower CNR risk was observed among men from D and E socio-economic classes (OR: 0.46; p= 0.058) when compared to those from classes A and B, which is what justified the inclusion of the socioeconomic class in the final model. The model adjustments by the Hosmer & Lemeshow's test were p=0.90 for women and p=0.47 for men.

Discussion

In this study, regardless of the indicator used, a high prevalence of obesity and overweight was observed in the population over 15 years of age in Ouro Preto. Among women, overweight/obesity was 48.2% and among men, 35.5%, when using BMI. When the waist circumference was the criterion, the results were approximately 54.2% and 22.4%, respectively, for women and men. These data suggest that individuals with normal or overweight BMIs, particularly women, may show central obesity indicating that characteristics of fat distribution should be taken into consideration when evaluating nutritional risks.

Some studies have shown that the BMI score may underestimate or overestimate overweight and obesity[5,8], since despite its correlation with excess body fat, the index would only reflect body proportions without estimating adiposity and the distribution of body fat.[5] On the other hand, WC measurement has recently started to be used as a health risk indicator[4,9,14,22,27].

Despite the lack of national data in Brazil on the prevalence of central overweight and central obesity, its epidemiological relevance has been increasingly demonstrated for the analysis of the nutritional risk for non-transmissible diseases because of its good correlation with visceral fat deposits[10,11,28]. Based on our current understanding of visceral triglyceride deposit metabolism[29], both indicators have proved to be adequate predictors of metabolic complications. Triglyceride deposits in the visceral organs have a higher turnover than in other regions,

Original Article

Characteristics	Female			Male		
	Combined risk*			Combined risk*		
	W/o % (n)	W/% (n)	p+	W/o % (n)	W/ % (n)	p+
Age						
15-19 years	72.9 (43)	27.1 (16)		88.2 (60)	11.8 (8)	
20-39 years	50.9 (88)	49.1 (85)		67.4 (118)	32.6 (57)	
40-59 years	25.9 (29)	74.1 (83)		50.0 (49)	50.0 (49)	<0.01
≥ 60 years	15.2 (7)	84.8 (39)	<0.01	36.8 (14)	63.2 (24)	
Schooling&						
Low	29.4 (58)	70.6 (139)		56.6 (90)	43.4 (69)	
Middle	64.9 (50)	35.1 (27)		67.6 (69)	32.4 (33)	0.05
High	50.9 (59)	49.1 (57)	<0.01	69.8 (81)	30.2 (35)	
Socioeconomic class#						
D/E	39.0 (73)	61.0 (114)		70.5 (105)	29.5 (44)	
C	46.8 (72)	53.2 (82)		60.0 (96)	40.0 (64)	0.10
A/B	47.9 (23)	52.1 (25)	0.28	58.8 (40)	41.2 (28)	
Sedentarism						
No	42.4 (36)	57.6 (49)		64.9 (111)	35.1 (60)	
Yes	43.1 (132)	56.9 (174)	0.90	62.4 (126)	37.6 (76)	0.61

*Without risk: WC < 80 cm (women) and < 94 cm (men) and low weight or normal BMI; With risk: WC ≥ 80 cm (women) and WC ≥ 94 cm (men) regardless of BMI category or individuals in the overweight or obesity BMI categories. &Schooling: Low: illiterate to incomplete primary; Middle: complete primary to incomplete secondary; High: complete secondary to higher education. #Socioeconomic class: A/B: high to middle. C: low middle. D/E: low to very low. +P value (χ^2 Pearson): proportion comparison among strata of the same indicator.

Table 5 - Prevalence of combined nutritional risk (BMI and WC) by gender, according to sociodemographic characteristics

increasing the release of free fatty acids to the portal venous system, stimulating gluconeogenesis, and inhibiting insulin clearance in the liver, as well as contributing to increased glycemia, insulinemia, and insulin resistance[4,29,30], with the resulting increase in arterial hypertension, cardiovascular diseases, and cancer[9,31].

In this study, according to the INR classification (WC ≥ 80 cm among women and ≥ 94 cm in men) and BMI, three different categories of individuals were found. The first two consisted of individuals with central overweight (moderate INR) or central obesity (high INR), but with normal/overweight or obesity BMI scores, and those with a normal WC (low INR), but classified as overweight or obesity according to the BMI. Possible explanations for these inconsistencies could be attributed to the uneven distribution of body fat or muscle mass that could be increased by the type of physical activity adopted by some individuals classified as being overweight or even obese, according to the BMI[5,8]. However, no health risks were reported in the second hypothesis [8,32]. Nevertheless, it is probable that this hypothesis is not applicable to Ouro Preto, particularly if we take into account the high prevalence of sedentarism in this population, be it among normal weight individuals or in those overweight or obese[33]. Therefore, the first hypothesis remains, in which the results suggest, once again, that BMI alone could be under- or overestimating the prevalence of risks, making it difficult to screen the population with a nutritional risk if WC is not taken into consideration[3,7].

In the population studied, women aged 40 years or older with low education levels had a higher prevalence of CNR when compared to those in other strata. These data are similar to those reported by other national studies[10,15,16]. Among men, in addition to what was observed among women, a low and very low economical status was also associated with RNC; however, its prevalence was lower than in other classes. These results are also consistent with findings in literature regarding socioeconomic classifications, i.e., that men in higher socioeconomic classes show a higher prevalence of nutritional risk[15,34].

The adjusted analysis confirmed the independent roles of age and level of education in a higher nutritional risk for women and men, findings similar to those observed by other authors[35,36]. It also showed that among young adult men (20 to 39 years of age), there was a high odds ratio (OR) for CNR which could suggest an early risk for hypertension, diabetes mellitus, and cardiovascular diseases for men. Additionally, it might possibly explain the higher rates of mortality due to circulatory tract diseases in the city of Ouro Preto among these individuals in all age groups, relative to women under 50 years of age[37].

As to schooling, the association was different between women and men. Women with less schooling had a higher odds ratios (OR) for CNR, whereas among men, the CNR was higher among those in the middle level of schooling.

	Gross OR		Adjusted OR	
WOMEN	OR (IC 95%)	p[+]	OR (IC 95%)	p[+]
Age				
15-19 years	1.00		1.00	
20-39 years	2.66 (1.39; 5.10)	<0.01	2.41 (1.24; 4.66)	<0.01
40-59 years	7.69 (3.76; 15.70)	<0.01	6.04 (2.81; 13.00)	<0.01
≥ 60 years	14.61 (5.50; 38.91)	<0.01	9.95 (3.55; 27.88)	<0.01
Schooling[&]				
> 4 years	1.00		1.00	
≤ 4 years	3.16 (2.07; 4.78)	<0.01	1.74 (1.06; 2.87)	0.03
Class[#]				
A/B	1.00		1.00	
C	1.04 (0.55; 1.99)	0.90	0.86 (0.42;1.77)	0.69
D/E	1.42 (0.75; 2.68)	0.28	1.15 (0.55; 2.40)	0.71
MEN	OR (IC 95%)	p[+]	OR (IC 95%)	p[+]
Age				
15-19 years	1.00		1.00	
20-39 years	3.64 (1.63; 8.12)	<0.01	5.02 (2.09; 12.08)	<0.01
40-59 years	7.54 (3.26; 17.42)	<0.01	10.14 (3.87; 26.59)	<0.01
≥ 60 years	12.62 (4.65; 32.24)	<0.01	14.35 (4.67; 44.08)	<0.01
Schooling[&]				
High	1.00		1.00	
Middle	1.12 (0.63; 1.98)	0.71	2.55 (1.24; 5.23)	0.01
Low	1.80 (1.08; 2.98)	0.02	1.91 (0.96; 3.78)	0.06
Class[#]				
A /B	1.00		1.00	
C	0.95 (0.53; 1.70)	0.87	0.88 (0.43; 1.77)	0.71
D/E	0.60 (0.33; 1.09)	0.09	0.46 (0.21; 1.03)	0.058

[#] *Socioeconomic class: A/B: high to middle. C: middle to low. D/E: low to very low.*
[&] *Middle and high levels of schooling pooled.* [+]*P value of the adjusted model (Wald test)*

Table 6 - Odds ratios (95% CI) of combined nutritional risk (BMI and WC) by gender according to sociodemographic variables

One possibility to be investigated would be that the gradient of this association could have been influenced by the type of occupational activity undertaken by men[5,8,38,39]. That is, men in low or very low socioeconomic classes could have heavy occupational activities demanding intense physical activity, which could contribute to the trend towards lower risks in this study. However, the indicators employed in this study did not allow an accurate verification of the type of physical activity undertaken, since only occupational and leisure activities of the individuals, and not their functional capacity, were taken into account, and neither did these indicators allow a measurement of the direction of the correlation.

It is also worth pointing out that the utilization of adult reference standards for the classification of WC in adolescents may have lead to the systematic underestimation of the population with CNR, since as per reports in literature, the proportion of body fat is age-dependent and adolescents tend to have a smaller proportion of intra-abdominal fat when compared to adults[29]. However, there are very few studies that establish the relationship between nutritional risk for non-transmissible diseases in this group, and in the absence of specific criteria, values determined for adults have been employed for the younger population[11].

Despite the limitations inherent to cross-sectional studies in establishing causal inferences, we concluded that age and schooling were independent factors associated with nutritional risk for both genders. In addition, we found that BMI alone did not seem capable of capturing the different categories of nutritional risk, since in this study 17% of women classified as having normal weight by their BMI scores

Original Article

showed an increased nutritional risk evaluated as per their WC measurements.

These findings, therefore, along with those reported by other authors, aggregate evidence for the possible underestimation of nutritional risk when only one indicator is used in the evaluation[3,7,40], as is the case with the BMI. The proposal made by Zhu et al[13], for a combination of the two indices (BMI and WC) in the process of identifying factors of cardiovascular risk, with specific combined risk points for white women and men, adjusted for co-variables such as physical activity, smoking, alcohol consumption, and schooling, is corroborated by the findings in our study.

Moreover, the findings in this study allow us to reflect on the relevance of the combined use of BMI and WC at health care units in order to increase accuracy in diagnosing nutritional risks, and the importance of considering age and schooling.

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Original Article

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