Research Article
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Association between body mass index and chronic non-communicable diseases among the elderly chronic diseases, body mass index and elderly

Abstract

Objective: The aim of this study was to verify the association between body mass index (BMI) and multimorbidity in elderly.

Methods: three-hundred and ten (n=310;71,62±8,15years) subjects were recruited in a cross-sectional study in the city of Ibicuí-BA, randomly selected and enrolled to the program "Estratégia de Saúde da Família"/ "Strategy of Family health". The data were collected through self-report questionnaires and consultation of the clinical record when socio-demographic information; global health; diseases and pathologies associated; lifestyles/risk behavior and body composition were consulted.

Results: Multiple linear regression analysis revealed significant associations existing between non-communicable diseases (NCD's), multimorbidity and BMI ($p \leq 0,05$). The highest values of BMI were associated with hypercholesterolemia in women, while in men there was a correlation with hypertension.

Conclusion: The results corroborate the scientific evidence that the increased BMI is directly related to increased exposure to multimorbidity by NCD's.

Keywords: elderly, morbidity, chronic diseases, body mass index

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Introduction

The demographic profile of Latin America has changed in recent decades with an increase in the number of elderly.[1] In the Brazilian context, the elderly increased the growth estimates from 9.1% in 1999[2] to 12.1% in 2011.[3] This scenario favors the changes in the morbi-mortality profile in the country, resulting in the increased prevalence of chronic and degenerative diseases[4,5] and as a result a subsequent increase in expenses with public health.[6]

Chronic non-communicable diseases (NCD's) constitute a high problem in public health, mainly in contemporary societies.[7] Estimates suggest that about 35 million people all over the world died from chronic diseases, which corresponds to the double of deaths related to infectious diseases, with an exponential increase in the elderly[7,8] population.

The imminent risk of death associated with the accumulation of NCD's becomes even more aggravating when added to some risk behaviors.[9] In Brazil, the NCD's are responsible for 72% of the mortality rate representing the most important health problem of the elderly population, reaching 69,3% of the men and 80,2% of the women.[10] Being chronic processes, this group of diseases demand constant and permanent care which may lead to "decades" of use of health services in a continuous and/or intermittent way.[11] The existence of two or more NCD's, a recurring situation in the elderly population, is characterized as presence of multimorbidity.[12,13] Among the risk factors for the multimorbidities, obesity presents itself as one of the most important due to its exponential growth in contemporary societies.[14,15] Studies that tried to associate the parental relationship and obesity prove that the risk of multimorbidity increases by 2,03 times when the individuals of both genders are obese.[12]

The associations between a high body mass index (BMI) related to overweight/obesity and the increase in the incidence of NCD's in the elderly population becomes increasingly evident[16] The quality of nutritional intake, one of the underlying aspects of malnutrition in the elderly and low levels of physical activity, for example, appears to be associated with weight gain, with multimorbidities and it also seems to be strongly related to low socioeconomic status.[17] Furthermore, susceptibility to the contraction of NCDs is directly proportional to the socioeconomic status, especially those related to cardiometabolic diseases.[18]

NCDs, together with overweight and with low body weight are increasingly frequent situations in the elderly population.[19,20] Recent research have shown strong associations between overweight/obesity and diabetes,[21] hypertension,[22,23] osteo-articular diseases[19] and disabilities.[21,24] On the other hand, low body weight is associated to chronic respiratory diseases and high mortality rate.[25] Limited access to primary health care,[26] little control of the nutritional status in the elderly as well as the access to inappropriate drug therapies,[27] are recurring aspects in the elderly and have a direct influence on the health related quality of life in the elderly person.[28,29]

The studies that try to establish these relationships, that use evaluation methods establishing models of association of variables in an independent and combined way[30] are still uncommon, mainly among the elderly with a low socioeconomic profile.[29] In spite of the existence of public primary care health services and hospital services in these regions, there's a great challenge with regard to its proper scope. Factors such as population density, low investment in areas not regarded as urban centers,[31] the number of health agents,[31] the demand for medical services[28] are all common factors to these regions and may cause differences in the health profile of these populations. In this sense, the purpose of this study was to analyze the association between body mass index and NCD's in elderly patients with low economic status.

Materials and methods

Study characterization

A cross-sectional study,[32] with secondary analysis of epidemiological data, based on the population and home-based, was held in the city of Ibicuí-BA, in February 2015. The municipality of Ibicuí is located in the physiographic area of Vitória da Conquista (Encosta do Planalto) and located in the southwest of the State of Bahia, with an estimated population of 15,785 inhabitants.[16] Of these, 1,153 aged 60 years or more.

Size of the study sample

The target population of this study consisted of individuals aged 60 years nd over, registered by the Community Health program 'Family Health Strategy' (FHS). To determine the size of the sample we used the criteria for finite populations proposed by Luiz & Magnanini,[17] being adopted for these calculations a significance level of 5% (confidence interval of 95% and tolerable error of 3%, z [a]/2=1.96). At the end of the sample calculus 10% more individuals were included in the sample to compensate for possible sample losses. The selection was performed randomly in a ratio of 1:2, i.e. for three selected medical inventories, one participant was included in the study and two deleted. To do this, we used the Epi Info 6.4 software, with a representative sample of elderly enrolled in the health services of the municipality and proportional distribution by age and sex. The initial sample was composed by 1.146 elderly that after the application of the sample selection criteria (described below) and subsequent stratification by the above random method reached the final sample composed by 310 elderly of both genders. The figure describes the path for sample selection as well as the frequency of the response rate of the study participants.

Data collection

Data collection was performed by a team of trained research assistants previously prepared for this purpose. Through phone calls conducted by research assistants, the participant was signaled to attend a routine medical appointment. Moreover, home visits were made by research assistants as one of the ways for collecting the data for the study, when the elderly had difficulties to go to the HFU in the month of collection. Research assistants provided assistance to some elderly, by reading documents aloud; running record of the options of response desired by the participants and was trained not to issue any judgment on the response options of the research participants.

Sample selection criteria

Inclusion criteria: To participate in the study spontaneous and voluntarily, after reading the consent and explanation term on the objectives of the research research; to be 60 or more and of both genders; to be enrolled in the FHS's that are participating in the study and take part in the study spontaneously. As for the exclusion criteria they were: withdraw from the study bedridden elderly, patients with dementia, Alzheimer's disease, Parkinson's or other neurodegenerative disease, elderly people with vision problems and severe hearing. Elderly people with another place of residence, absence of the residence after 3 consecutive visits or missing 3 appointments at the health unit and direct refusals were withdrawn from the sample.

Measurements

The collection of the information was performed by instruments validated according to the Brazilian reality and also, through a questionnaire of biosocial nature, of semi-structured type developed for this purpose. The information was obtained in the form of self-administration. However, in some cases where inconsistency in the speeches was detected, consultation was held to recall/medical records of the participant provided by the local nurse to prove the veracity of the obtained data. Information was included about the health risk behaviors, lifestyles, socio-demographic indicators and the NCDs, based on the conceptual guidelines of the multidimensional model of life quality related to health according to the World Health Organization. The objective parameters were obtained through appropriate collection instruments; all described in the topics that follow.[7]

Dependent variable

Chronic Non-Communicable diseases: we included the stroke, diabetes mellitus, hypertension, cancer, high cholesterol, chronic lung disease, asthma/bronchitis, other respiratory diseases (eg: allergies.), coronary heart disease, rheumatism, common mental disorders.

Independent variable

Body mass index; Body composition: Body mass was measured with a portable digital scale (OMRON®) and to evaluate the height a stadiometer (brand Sanny®) was used, both calibrated for measurements. BMI, evaluative measure used with indicator of nutritional status was obtained through the assessment of body mass and height, calculated by the formula [BMI = body weight (kg)/height 2(m)], whose procedure followed a standardized protocol.[33]

Model adjustment variables

Sociodemographic variables: gender (male and female), age (continuous variable), education level ('literate' and 'illiterate'), living arrangements ('live with' or 'unmarried'). Analysis of lifestyles and health risk behaviors, the following information was computed:

daily consumption of alcoholic beverages ('yes' or' no '), smoking (' ever smoked, 'never smoked', 'currently smoking') and level of physical activity during leisure time (answer 'yes': mild, moderate or severe, 'not' I do not do any physical activity in leisure time). Presence of Common Mental Disorders (CMD) was used the Self-Reporting Questionnaire (SRQ-20). The SRQ-20 is the version of 20 items of SRQ-30 for screening non-psychotic mental disorders; the responses are dichotomous yes / no. Each affirmative response scores to the value of one (1) to compose the final score of the scale, obtained by the sum of these values. In the TMC classification, it was adopted the cutoff of five or more positive responses.[34]

Non communicable chronic deseases: they were defined from the NCD's number. the rate of occurrence was found by a question with two answer choices being the yes indicative of two or more diseases and conditions and the answer 'no' option for the occurrence of one disease or none.[35,36]

Waist circumference: The waist circumference was measured using inelastic tape, measured at the narrowest part of the abdomen or the midpoint between the last rib and the iliac crest. Reference Manual procedures were followed for standardization of anthropometric measurements.[33]

Statistic procedures

As a preliminary procedure, we proceeded to the introduction of data which were twice retyped and validated in the computer program Epi Info 6.04 developed by the Center for Disease Control and Prevention, Atlanta-United States.[37] For the descriptive analysis, the proportions of individuals depending on the categories, expressed in percentages, according to the variable analyzed. The evaluation of the differences between the genders in the descriptive variables was performed using the chi-square test. To correct the effects of the covariates and test the influence of the independent variables, the association between BMI and NCD's was performed by multiple linear regression analysis (CI: 95%). To this end, were considered three regression models using the BMI as a reference variable. The models were built considering the quality of life construct related to health of the WHO.[38] Associations between BMI and NCD's whose matrix comprises the adjustment through the variables age, family structure and education were explored in model 1. Model 2 includes the variables age and education, family structure, smoking, waist circumference, physical activity and alcohol consumption. The model 3 has an adjustment matrix that considered all of the above variables, including the assessment of multimorbidities. BMI values were analyzed as a continuous variable. In all analyzes we used a significance level of 5%.[39,40] Data were analyzed using the statistical program SPSS 22.00.

Ethical procedures

All procedures were previously avaliated and approved by Ethical Committee of Universidade Estadual do Sudoeste da Bahia (CAAE: 22969013.0.0000.0055). This study followed the statment of ethical principles presented on Declaration of Helsinki[41] and on the resolution law nº 466/2012 of National Commitee of Health to conduct research with humans.[42]

Results

Among respondents the average age was 71.62±8.15 years. There was a higher percentage of women (56.5%), individuals aged 60-79 years (83.9%), literacy (56.1%), living without a partner (51.0%) and in a state of co-residence (78.4%). The average monthly income of the investigation was R $ 708.26±303, 69 reais. With regard to lifestyle, most said they do not consume alcohol daily (95.8%), and reported not currently smoking (88.4%). Regarding the level of physical activity during leisure time, 68.7% of the elderly were inactive in their free time.

As to those diseases, 13.5% of seniors referred heart disease, 64.2% had hypertension, 31% had hypercholesterolemia and 24.8% with circulatory diseases. The overall prevalence of multimorbidity was 80.3%, it was identified higher prevalence of multimorbidity among elderly women (73.7%) against 45.9% male.

Table 1 shows the results of the crude analysis of the associations between chronic diseases and body mass index for men and women. In women, BMI was 1.90kg/m^2 higher for those with hypertension and 1.74kg/m^2 times higher for those with hypercholesterolemia 2.94kg/m^2 times greater for those with circulatory diseases and 2.63kg/m^2 times higher for those who reported a diagnosis of rheumatism. In men, only hypertension was associated with BMI (Table 1).

Table 1 Multiple linear regression, between each chronic disease and body mass index according to the sex of the participants (n = 310)

	Women(N=175)		Men (N=135)	
	B (CI:95%)	P	B (CI:95%)	P
High Blood Pressure	1,90 (0,207; 3,60)	0,028	1,43 (0,09; 2,76)	0,036
Diabetes mellitus	0,79 (-1,64; 3,22)	0,523	0,16(-161; 1,94)	0,852
Asthma and bronchitis	-0,42 (- 3,68; 2,83)	0,797	1,38(- 3,13; 5,90)	0,545
Stroke	0,05 (- 3,20; 3,32)	0,972	1,09(- 1,57; 3,76)	0,417
Other Respiratory diseases	- 1,25 (- 2,88; 0,38)	0,133	- 0,63(- 2,09; 0,83)	0,395
Hypercholesterolemia	1,74 (0,20; 3,28)	0,027	1,12 (- 0,71; 2,95)	0,228
Choronary Heart Disease	2,94 (1,29; 4,59)	<0,001	- 0,53(- 2,20; 1,13)	0,527
Rheumatism	2,63 (1,04; 4,22)	<0,001	- 0,98- (2,44; 0,46)	0,182
Common Mental Disorders	0,79 (- 0,86; 2,45)	0,345	- 1,28(- 2,63; 0,05)	0,060

(**p≤0.001;*p≤0.005*); CI: Confidence Interval.

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Table 2 shows the results of the adjusted analysis of the associations between NCD's and BMI for women. Considering the model 1 adjustment variables (age, family structure, and education), the association between the higher BMI and chronic diseases were kept. In the adjustment of model 2 (age, education, family structure, smoking, waist circumference, alcohol consumption and physical activity), hypertension, circulatory diseases and rheumatism lost magnitude of association in the BMI. In the final model, only hypercholesterolemia was independently associated with BMI.

Among men, when related to BMI and the three models in the regression analysis, only the 'blood pressure' remained associated with increased BMI (Table 3).

Table 2 Multiple linear regression analysis between body mass index and non-communicable chronic diseases in women, adjusted for the three models (n = 175)

	Model 1		**Model 2**		**Model 3**	
	β (CI:95%)	**P**	**β (CI:95%)**	**P**	**β (CI:95%)**	**p**
High Blood Pressure	1,85 (0,16; 3,55)	0,031	- 0,80 (- 0,97; 0,81)	0,860	- 0,53(1,49; 0,42)	0,273
Diabetes mellitus	0,66 (-1,80; 3,13)	0,596	0,12(- 1,14; 1,36)	0,860	0,04(- 1,26; 1,34)	0,951
Asthma e bronchitis	- 0,69 (- 3,94; 2,56)	0,675	- 1,30(- 2,94; 0,32)	0,116	- 1,25(- 2,99; 0,49)	0,158
Stroke	0,17 (- 3,08; 3,42)	0,916	0,14(- 1,52; 1,81)	0,865	0,12(- 1,55; 1,81)	0,881
Other Respiratory diseases	- 1,32 (- 2,97; 0,32)	0,114	- 0,26(- 1,13; 0,60)	0,547	- 0,37(- 1,32; 0,58)	0,442
Hypercholesterolemia	1,61 (0,56; 3,17)	0,042	0,96(- 0,14; 1,77)	0,021	1,01(0,11; 1,90)	0,027
Choronary Heart disease	2,80 (1,14; 4,46)	<0,001	0,75(- 0,17; 1,68)	0,109	0,72(- 0,28; 1,72)	0,159
Rheumatism	2,73 (1,07; 4,39)	<0,001	0,68(- 0,21; 1,58)	0,135	0,33(- 0,64; 1,30)	0,506
Common Mental Disorders	0,71 (- 0,94; 2,37)	0,395	0,01(- 0,84; 0,87)	0,969	- 0,09 (- 0,98; 0,79)	0,829

(**p≤0.001 *p≤0.005); BM, confidence interval; multiple regression model 1, adjustment for age + family arrangement + education - Model 2, adjustment for age + education + family arrangement + smoking + waist circumference + alcohol + physical activity - Model 3 adjustment for all of the above variables and for all diseases and disorders

Table 3 Multiple linear regression analysis between body mass index and chronic non-communicable diseases in males, adjusted for the three models (n = 135)

	Model 1		**Model 2**		**Model 3**	
	β (CI:95%)	**p**	**β (CI:95%)**	**p**	**β (CI:95%)**	**p**
High Blood Pressure	1,30 (0,11; 2,59)	0,048	1,16 (0,11; 2,21)	0,030	1,39(0,22; 2,55)	0,020
Diabetes mellitus	0,44 (- 1,26; 2,14)	0,608	0,02 (- 1,35; 1,40)	0,973	- 0,19(- 1,66; 1,28)	0,797
Asthma e bronchitis	2,85 (- 1,54; 7,25)	0,201	0,90(- 2,75; 4,56)	0,625	1,74(- 2,05; 5,54)	0,366
Stroke	0,81 (- 1,73; 3,36)	0,530	- 0,02(- 2,10; 2,06)	0,985	- 0,53(- 2,73; 1,66)	0,631
Respiratory diseases	- 0,36 (- 1,79; 1,06)	0,612	- 0,26(- 1,42; 0,90)	0,659	- 0,66(- 1,91; 0,59)	0,297
Hypercholesterolemia	0,78 (- 0,99; 2,55)	0,385	0,24(- 1,20; 1,68)	0,744	0,51(- 1,06; 2,09)	0,517
Choronary Heart diseases	- 0,27 (- 1,89; 1,35)	0,741	- 0,31(- 1,64; 1,01)	0,643	- 0,57(- 2,08; 0,93)	0,452
Rheumatism	- 0,53 (- 1,94; 0,88)	0,457	- 0,60(- 1,75; 0,53)	0,295	- 0,58(- 1,89; 0,72)	0,378
Common Mental Disorders	- 0,754 (- 2,08; 0,57)	0,263	0,36(- 0,74; 1,47)	0,518	0,55(- 0,64; 1,76)	0,360

(**p≤0.001 *p≤0.005*); CI, confidence interval; Multiple Regression Model 1, adjusted for age + family arrangement + education; Model 2, adjustment for age + education + family arrangement + smoking + waist circumference + alcohol + physical activity; Model 3, adjustment for all of the above variables and to all diseases and disorders

Figure 1 shows the trend graph for NCD's number and BMI for men and women. The BMI of women with 2 or more of the diseases was slightly higher compared to those with 1 or no disease. For men, the BMI of those with 2 or more diseases was higher than that of individuals reporting no or 1 disease.

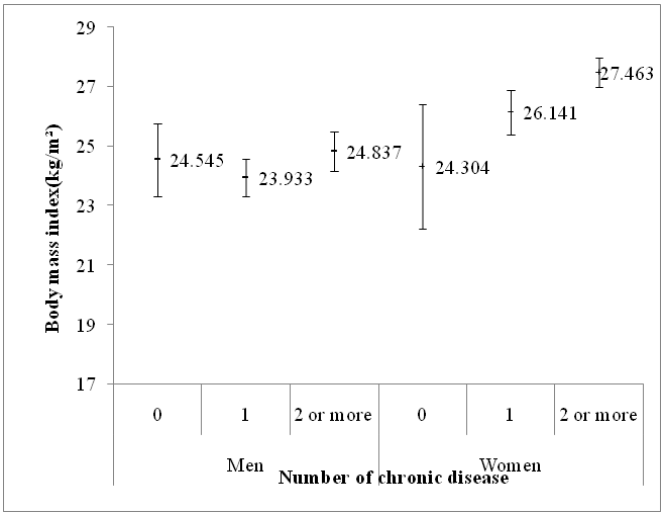

Figure 1 Graph of the mean analysis of the BMI and assessment of NCD's analyzed by gender of the participants.

Discussion

This is one of the few studies carried out in Brazil in which the epidemiological survey seek to analyze the association between NCD's, socio-demographic indicators, risk behavior factors and lifestyle nutritional status (BMI) in elderly with low economic status. Very common in epidemiological studies, the obtainance of self-reported health data may not guarantee their reliability,[18] so the option for direct consultation to the doctoris files in cases where the elderly had doubts.

Our results showed significant differences between genders in the estimates of NCDs and in the association between NCDs, multimorbidities and BMI. Among females, hypercholesterolemia remained associated with higher BMI. While among men, hypertension was associated with higher BMI after the multivariate analysis. Moreover, there was a significant linear relationship between the number of diseases and BMI for men and women, revealing a trend of more NCDs among individuals with higher BMI scores.

Independently from the analyzes by gender, it is quite clear that in this study sample, the BMI seems to establish a direct relationship with the group of cardiometabolic diseases. The differences in the association between gender, NCDs and BMI observed in this study corroborate the findings in recent studies.[43,44]

Epidemiological studies show differences in distribution of NCDs in genders,[34,35] with a higher prevalence of chronic diseases among women.[45,46] Aspects such as greater demand for health services and longer life expectancy, may contribute to greater presence of chronic diseases among women.[47] After the adjusted analysis, hypercholesterolemia remained associated with higher BMI values for women. Study results from Framingham show that the increase in total body fat related to aging, increases the likelihood of metabolic disorders such as the increase in glucose and hypercholesterolemia.[48] Among men, independently from behavioral, sociodemographic factors and presence of other NCDs, hypertension remained associated with higher BMI scores. A recent study with elderly population in the city of São Paulo showed that BMI was strongly associated with high blood pressure, which was similar to the findings of the present study.[22] The authors also identified that the elderly male with a BMI≥27k/m^2 is 85% more likely to develop high blood pressure compared to those with BMI<27kg m^2. The information collected in this study slightly contrasts with the statement that in the elderly a higher BMI value is directly related to lower risk of mortality.[49]

The high BMI has been associated with risk factors for blood hypertension.[23] Individuals with higher BMI scores show physiological changes in the sympathetic nervous system, renin-angiotensin-aldosterone system, endothelial dysfunction and functional abnormalities.[23,22,50] These modifications increase the exposure to hypertension and cardiovascular disease, which can certainly be explained by the increased of the body fat mass.[50,22] Although not significant, there was a significant correlation from the clinical point of view between the number of diseases and BMI in men and women. In individuals of both genders the average BMI was higher among those who reported two or more diseases, regardless of the adjustment variables.

The findings about the relationship between multimorbidities and BMI with representative samples still present reduced numbers, only one population study carried out by adults in the UK identified this relationship quite clearly showing a prevalence of multimorbidity of 23%, increasing with the increase of BMI, reaching 44% in subjects with class II obesity, suggesting that multimorbidities may result from overweight/obesity.[16]

Although multimorbididity presents itself as a public health problem, it has a negative impact on quality of life of the elderly,[24,47] it can be noted that the possible mechanisms involving the relationship between multimorbidities with some risk factors such as BMI are still not fully understood.[51,52] However, from the results found and the evidence from literature it appears that increasing BMI is directly related to increased exposure to NCDs morbi-mortalities. Aspects such as low economic status, low education, poor diet, sedentary lifestyle, poor access to primary health care are conditions that may increase the magnitude of this association.

Among the study's limitations, we can highlight the methodological design, as the cross-sectional study does not allow assessment of the cause and effect between the variables. Recall bias may have influenced the response variable diseases mentioned; however, this measure is widely used in epidemiological studies as an indicator of health status, especially in older people, as well as reported in other researches,[18] which favors the comparison between studies.[18] However, it is necessary to emphasize that this research was conducted with a little investigated population in Brazil, generating important information for health policy and clinical practice of professionals who care for the health of the elderly population.

Conclusion

The highest values of BMI were associated with hypercholesterolemia in women, while in men there was a correlation with hypertension. The highest means of BMI were identified among individuals with higher number of diseases. The results corroborate the scientific evidence that the increased BMI is directly related to increased exposure to multimorbidity by NCD's.[53–59]

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Conflict of interest

Authors declare there is no conflict of interest in publishing the article.

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