Impact of obesity and weight changes on disability and mortality in Brazilian older adults

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Abstract

Background: In the past three decades, obesity rates have increased in Brazil. Obesity has been associated with an excess burden of disability, but little is known about these associations in Brazil.

Methods: We use two waves of SABE in São Paulo, Brazil. Three measures of disability are included: activities of daily living (ADL), instrumental activities of daily living (IADL) and Nagi limitations.

Results: Compared to normal weight, individuals who were obese were more likely to have ADL (OR=5.0, 95% CI 3.6-6.9), IADL (OR=3.5 95% CI 2.6-4.8) and Nagi (OR=6.9, 95% CI 5.1-9.4). Individuals who were underweight or overweight faced higher disability at the baseline than those of normal weight. Over time, obesity was associated with higher incidence of ADL (RRR=2.78, 95% CI, 1.74-4.43) and IADL (RRR=2.15, 95% CI 1.38-3.36). Being obese was associated with higher risks of remaining ADL disabled (RRR=3.66, 95% CI 1.69-7.94), IADL disabled (RRR=2.18, 95% CI 1.36-3.49) and with Nagi limitations (RRR=3.96, 95% CI 2.13-7.34). Compared to those who maintained their weight, those who gained weight experienced higher incidence of ADL (RRR=2.3, 95% CI 1.11-4.77), IADL (RRR=2.07, 95% CI 1.05-4.10) and Nagi limitations (RRR=2.26, 95% CI 1.28-3.97), even after controlling for initial BMI categories. Higher mortality among obese individuals was only found when the reference category was remaining free of Nagi limitations.

Discussion: This study confirms that obesity is associated with increased disability in Brazilian older adults.

KEYWORDS: aging, body mass index, weight changes, Brazil, life expectancy, disability.

Background

Brazil is among the 25 countries in the world with the fastest aging rates [1, 2]. In 1950, 2.6 million (4.9%) Brazilians were older than 60 years of age and estimates for 2010 indicate that 20 million people (10.3%) are in this age group [3]. Improvements in medical care and living standards have been translated into higher life expectancy. In 1950, life expectancy at birth in Brazil was 50.9 years but has since increased to 72.2 years in 2010 [3]. However, the number of disabled people is expected to increase in the coming years given the rapid growth rate of elderly population and the rise in the prevalence of obesity and chronic diseases [4].

Fast changes in the nutritional intake that have taken place in Brazil in recent decades [5] resulted in an increase in the prevalence of obesity in the country [6-8]. In the past three decades, obesity rates in Brazil tripled among men and almost doubled among women [8]. Prevalence of obesity is higher among women than among men; except for urban women with the highest income group [6, 9].

Obesity has been associated with higher prevalence of disability in cross-sectional and longitudinal studies [4, 10-12]. This positive association has been found among middle and old age adults [11, 12-14] and it appears this association has not changed over time [15, 16]. Additionally, the association between body mass index (BMI) and disability is strongest among those who are underweight (BMI<18.5 kg/m^2) and among obese subjects (BMI >30 kg/m^2) [4, 10]. Obese women face higher prevalence of mobility impairment than men [12]. In the U.S., severe functional limitations are higher among older adults who gain or lose weight after age 50 compared to those with stable weight [17]. Emerging evidence supports that BMI and waist circumference are important predictors of the onset of mobility limitations [12]. Older adults in the U.S who had gained weight over time have higher incidence of mobility limitations than those who maintained their weight [18].

The relationship between BMI and mortality seems to follow a J-shaped (sometimes U-shaped) curve at older ages [15, 19-20]. All-cause mortality seems to be lowest at BMI levels between 20 and 24.9 kg/m² [20, 21]. In developed countries, comprehensive reviews of past studies indicate that overweight and obese individuals face higher mortality risks than normal weight counterparts [20-22]. Recent studies, however, show that overweight individuals seem to have higher life expectancy than individuals of normal weight or those who are obese in developed countries [11]. Higher mortality at low levels of BMI has been associated primarily with lung cancer and respiratory diseases [21]. Nevertheless, at older ages, the burden of obesity on mortality seems to be reduced or eliminated [10, 23-32] as the BMI level associated with lowest mortality rates increase with age [15]. Even though BMI has been widely used to assess the impact of body composition on disability and mortality, it has been criticized since it can be related to underlying health status [15]. One approach to address this limitation has been to take into account body weight changes [15].

There are few studies that focus on the impact of obesity on mortality and disability in Latin America and the Caribbean (LAC) region. Al Snih and colleagues [4] based on the baseline for the Health, Well-Being and Aging in Latin America and the Caribbean Study (SABE) show that individuals who were obese were 1.63 times more likely to have difficulties performing activities of the daily living than those with normal BMI [4]. Monteverde and colleagues [33] find that heavier older adults in Mexico face higher mortality risks than those in the U.S. based on relative cutoffs (quintiles). However, when BMI was categorized following the traditional World Health Organization cutoffs, no excess mortality was found among overweight and obese subjects [33]. In fact, coefficients for overweight and obesity were not in the expected direction [33]. Results from Mexico indicate a U-shaped curve for the association between BMI and mortality [33].

Due to the scarcity of research on the association of obesity and disability and its impact on life expectancies in LAC, there is a need for more research in this topic. In addition, previous studies had not explored the role of weight changes on disability transitions. This paper expands the current literature by using panel data from SABE study in São Paulo to provide estimates of the impact of obesity and weight changes on prevalence and incidence of disability as well as recovery from disability. We also explore the role of obesity on mortality risks.

Methods

We analyzed data from the two waves (2000, 2006) of SABE São Paulo, Brazil. SABE is a multi-center survey with respondents in seven capital/major cities throughout the countries of LAC that has been investigating the health and well-being of older adults (age 60 years and over). The Pan American Health Organization (PAHO/WHO), the Center for Demography and Ecology at the University of Wisconsin-Madison, and the National Institute on Aging provided funding and support for the general survey. In Brazil, the São Paulo State Research Foundation (FAPESP) provided additional support. Faculty members at the School of Public Health (Faculdade de Saúde Pública) and São Paulo University (Universidade de São Paulo) coordinated data collection in Brazil. The study was approved by the Institutional Review Boards at the collaborating institutions [34, 35]. Participants provided consent to have their data used for research purposes.

The baseline sample in São Paulo was obtained using a two-stage stratified sampling based on the 1995 National Household Survey master sampling frame. Individuals aged 75 years and over were oversampled. The data in the first wave were collected in two stages. The first stage was a household interview conducted by a single interviewer using a standardized questionnaire that included several questions about the living conditions and health status of the older adult. The second stage of the data collection was a household visit by a pair of interviewers who completed anthropometric and physical performance measurements. The data for the first wave were collected in 2000 and the first quarter of 2001. At baseline, the response rates reached 84.6% in São Paulo. In the first stage, we collected information on 2,143 individuals. Additional characteristics of the baseline data collection process have been described elsewhere [36-38].

In 2006, the São Paulo researchers conducted the first follow-up interviews to the 2000 baseline survey. The researchers used mortality data from the Fundação Sistema Estadual de Análise de Dados (SEADE foundation, which has analyzed relevant social, demographic, and economic data in the São Paulo state) and from the Programa de Aprimoramento das Informações de Mortalidade, which has collected and organized mortality data for the city of São Paulo to identify subjects who had died between 2000 and 2006. The search was based on the names, sex, dates of birth, and addresses listed in the 2000 database.

Trained interviewers visited the addresses and neighborhoods of the surviving participants from the 2000 survey to re-establish contact. For those not found during these visits, interviewers used the additional contact information collected at baseline (e.g., telephone numbers of children or other relatives) to obtain information about their current location. In 2006, researchers collected data via face-to-face interviews using a standardized questionnaire. The 2006 questionnaire was very similar to the 2000 questionnaire but included additional questions which complemented the previous study. Of the 2,143 participants in the first wave of

SABE São Paulo, 353 (16.5%) had missing data on selected variables [39]. Most had missing data on body mass index (BMI) measure. Those with missing data were older (75.0 years) than those with complete data (72.9 years) (p = .0001), but there were no sex differences. The prevalence of all measures of disability was higher among those with missing data (p < .001). There were 544 (25.4%) participants who died between the baseline and first follow-up. The final sample is composed by 1,790 individuals; a subset of 962 is included in the analyses with weight change.

Measures

Self-reported disability in six ADL measures—dressing, bathing, eating, getting in and out of a bed (transferring), toileting, and getting across a room—were used to measure disability. We dichotomized each of the ADL measures; a score of "0" indicated that the respondent did not have any disability, and a score of "1" indicated that the respondent had difficulty performing at least one activity in each scale. The IADL measure asked about the respondent's ability to prepare a hot meal, manage money, shop, and take medication. Individuals with IADL limitations are not as severely impacted as those with ADL limitations, but nevertheless face difficulties that may limit their ability to live independently within a community. The Nagi physical performance measure included lifting or carrying objects weighing five kilograms or more; lifting a coin; pulling or pushing a large object, such as a living room chair; stooping, kneeling, or crouching; and reaching or extending arms above shoulder level. Each of the three disability measures was converted to binary form, in which respondents scored "0" if they did not indicate any limitations, and "1" if they reported having difficulty performing at least one activity in the scale.

Body weight and height were measured without shoes and with light clothing by trained examiners. BMI was calculated as kg/m^2. Four BMI categories were defined according to the adult criteria: underweight (BMI ≤ 18.5), normal (BMI 18.5 – 24.9), overweight (BMI 25.0 – 29.9) and obese (BMI ≥ 30). Change in BMI is calculated as BMI in 2006 minus the BMI in the baseline. This difference was divided by the baseline BMI and then recoded into three categories: a) an increase of 5% or more, b) a decrease of 5% or more, and c) changes within 5% of the baseline weight (reference category) [18, 40].

We used STATA S.E. 12.1 for all the statistical analyses. Descriptive statistics are provided. We use multinomial logistic regressions to assess age, gender and BMI categories differences in subjects' trajectories between baseline and follow-up, with no inclusion of weight change. After, we use multinomial logistic regressions to analyze the role of weight change as well on health transitions, excluding mortality since we do not have information on weight change prior to death in between waves. In all regressions, smoking status was included (never, former, or current smoker).

Results

In Brazil, few older adults were underweight (3.7%), 36.3% had normal weight, 38.9% were overweight and 21.1% were classified as obese. Table 1 presents the prevalence estimates of disability according to measures of ADL, IADL and Nagi by sex and BMI category in the baseline. For the general population, the prevalence of ADL and Nagi was highest among obese individuals, followed by those underweight. Individuals who were normal or overweight had lower prevalence of ADL and Nagi limitations. Differences on ADL and Nagi across BMI groups were statistically significant ($p<0.001$). The prevalence of IADL followed a different pattern. Prevalence of IADL was highest among underweight individuals, followed by obese individuals. For all disability measures, the prevalence of disability was higher among women than men ($p<0.001$).

[Table 1 about here]

Weighted estimates indicated that 16.8% of individuals aged 60 years and over in São Paulo have difficulty in performing at least one ADL. Prevalence of IADL reached 24.5% and most (57.9%) of older Brazilian adults reported Nagi limitations. In analyses controlling for age and gender (not shown), compared to normal weight, individuals who were obese were more likely to have ADL (OR=4.98, 95% CI 3.60-6.90), IADL (OR=3.51, 95% CI 2.58-4.77) and Nagi (OR=6.90, 95% CI 5.08-9.38). Individuals who were overweight were also at increased risk of having ADL at baseline (OR=3.21, 95% CI 2.42-4.26), IADL (OR=2.82, 95% CI 2.18-3.65) and Nagi limitations (OR=3.67, 95% CI 2.90-4.63) compared to those of normal weight. Prevalence of ADL (OR=4.39, 95% CI 2.39-7.73), IADL (OR=7.93, 95% CI 4.44-14.16) and Nagi (OR=4.63, 95% CI 2.57-8.32) was higher among those who were underweight than normal weight.

Table 2 shows the multinomial logistic regression results of the disability transitions and mortality between 2000 and 2006. Compared to normal weight individuals, those obese were more likely to become ADL disabled (RRR=2.78, 95% CI, 1.74-4.43) and IADL disabled (RRR=2.15, 95% CI 1.38-3.36) between waves. Being obese was also associated with higher risks of remaining ADL disabled (RRR=3.66, 95% CI 1.69-7.94), IADL disabled (RRR=2.18, 95% CI 1.36-3.49) and continuing to have Nagi limitations (RRR=3.96, 95% CI 2.13-7.34). Recovery from Nagi was lower among individuals who were underweight. Those who were underweight were also more likely to die between waves than those of normal weight. Being older increased the likelihood of developing ADL, IADL and Nagi limitations. For all measures of disability, the risk of becoming disabled and remaining disabled increased with age. As expected, older ages were associated with higher mortality. However, after controlling for sex, BMI categories and smoking, older individuals were more likely to recover from IADL and Nagi limitations versus remaining without disability in both waves. Women also had higher chances of developing ADL and Nagi limitations, but not IADL. Women were also more likely to remain disabled based on all measures of disability. However, women faced higher recovery from Nagi than males in São Paulo after controlling for BMI categories and smoking variables. Mortality among women was also higher than the risks of remaining free of Nagi in both waves.

[Table 2 about here]

In the last set of analyses, we focus on the role of weight gain between waves on disability transitions. The analysis is restricted to those who have survived between waves. The results presented in Table 3 indicate that those who gained weight between waves are more likely to develop ADL (RRR=2.3, 95% CI 1.11-4.77), IADL (RRR=2.07, 95% CI 1.05-4.10) and Nagi limitations (RRR=2.26, 95% CI 1.28-3.97) than those who maintained their weight, even after controlling for initial BMI categories. Compared to those who maintained weight, those who gained weight were also more likely to remain with Nagi limitations (RRR=1.75, 95% CI 1.04-2.94) than to be free of Nagi in both waves.

Discussion

The current paper examined the impact of body mass index on health transitions and mortality. There is consistent evidence that obesity among older adults is associated with mobility impairments and disability [12, 14, 41, 42]. Our study confirms these findings as obese older adults in Brazil were more likely to have ADL, IADL and Nagi limitations than those of normal weight. Excess disability was also found among those who were overweight at the baseline. Higher levels of disability among obese and overweight subjects in Brazil had been previously reported, but were limited to the baseline sample [4]. Our study contributes to the literature by exploring the impact of obesity and weight changes on disability status transitions and on mortality.

Most longitudinal studies have found that obese older adults are more likely to have experience incidence of disability in the follow up than those of normal weight [12, 14, 27]. Our study confirms these findings. Older adult Brazilians who were obese at baseline faced higher risks of becoming disabled with ADL or IADL limitations compared to normal weight. However, being overweight was not associated with higher incidence of disability after controls were included in the analysis, which is consistent with previous findings [41]. In terms of recovery, we also found that individuals who were obese were more likely to remain disabled in the follow-up for all types of disability, which is consistent with previous studies [27]. Being overweight was associated with higher chances of remaining with Nagi limitations in the follow-up.

There is a growing interest in the role of weight changes on health transitions [12, 17, 18, 43]. Studies have shown that weight gain in older adults was associated with decreased physical function and role limitations [17, 18]. We found similar findings in which older adults who gained weight between waves were more likely to develop ADL, IADL and Nagi limitations than those who maintained their weight, even after controlling for initial BMI categories. Al Snih and colleagues [44] also reported higher ADL incidence among individuals who had weight gain of more than 5% between waves. Compared to those who maintained weight, those who gained weight were also more likely to remain with Nagi limitations than to be free of Nagi in both waves. Studies have reported contradictory findings related to weight loss. Some studies have indicated that weight loss is associated with improvements in mobility and functioning [12], whereas others have reported increased ADL disability [18]. Weight loss therapy among obese older adults seems to be beneficial for improving quality of life and physical functioning [45]. Ritchie and colleagues [43] found that intentional weight loss was not associated with functional decline, however those who unintentionally lost weight faced higher rates of functional decline, regardless of the initial BMI. Given the lack of data on intent related to weight changes, further studies are necessary to explore the impact of weight changes on mortality and disability in LAC.

This study found higher mortality among those who were underweight, which corroborate the findings of previous literature [15, 16, 33]. Excess mortality was not associated with overweight and obesity and this is consistent with previous studies suggesting that higher BMI may not be detrimental for mortality at older ages [11]. Monteverde and colleagues [33] also did not find statistical differences on mortality between higher BMI categories (overweight and obese) and normal subjects when using traditional BMI cutoffs. However, they reported statistical differences when BMI was categorized in relative terms. In our study, the only exception we found was among obese individuals who were more likely to die between waves compared to remain free of Nagi limitations in both waves.

Even though not central to our study, our findings contributed to a growing debate about whether greater life expectancy implies better health for the expanding surviving elderly female population in Latin America [37, 46-52]. Brazilian women experienced higher levels of disability than men, which is consistent with previous studies [53, 54]. Studies have indicated that Brazilian women face lower mortality than their men counterparts [37, 55]. Our analyses indicate that women face lower mortality than men when controlling for age [37]. When smoking and BMI categories are included in the current analysis, women were more likely to die compared to remain free of Nagi limitations. This result highlights the impact of Nagi limitations among women. Prevalence of Nagi was very high among women in São Paulo in the baseline. In particular, women were more likely than men to report having difficulties pulling or pushing a large object (37% vs. 22%, $p<0.001$), stooping, kneeling, or crouching (57% vs. 39%, $p<0.001$), reaching or extending arms above shoulder level (17% vs. 9%, $p<0.001$), lifting or carrying objects weighing five kilograms or more (46% vs. 23%, $p<0.001$), but there were no differences in coordination. In the follow-up, increases in the prevalence of Nagi were higher among women than men, which indicate that women are very unlikely to remain free of Nagi limitations as they age.

Aging is related to increase of fat mass and there is growing evidence of the detrimental impact of obesity on disability at older ages. There is evidence that changes in lifestyle, such as walking, have positive effects on preventing mobility limitations [56]. A large proportion of older adults, however, do not engage in physical activity. In a study based on a urban sample in Brazil, 71% of older adults reported as being sedentary [57]. When asked about neighborhood characteristics that are related to concerns to leave home, most (78%) reported fear of being robbed, while almost half (48.2%) said that they were afraid to fall because of sidewalks defects [57]. In multivariate analyses, fear of falling due to poor sidewalk conditions was associated with a 62% increase in the expected number of ADL conditions [57]. Therefore, investments aimed at improving urban infrastructure and safety may be effective in addressing the health conditions of older adults in Brazil.

This study further advances the literature on the impact of body weight and body weight changes over previous studies, particularly those conducted in Latin America. This is the first study we are aware of that explores the impact of BMI and its changes on disability transitions in Latin America. In addition, we use measured, not self-reported BMI data. However, this study has some limitations. First, the data used in the study on disability measures were self-reported. Although this could be a possible source of bias, methodological studies have shown that self-reported data on functional disability were consistent with medical diagnoses [58]. Second, the use of BMI as a measure for body weight composition among older adults is very controversial as it does not take into account body fat distribution [15]. In addition, BMI at baseline can be associated with health status [15, 16]. Therefore, it is important to control for weight changes, which we accomplished in this study. Some authors have argued that waist circumference or waist-to-hip ratio could be better predictors of disability and mortality [33], however most studies have focused on the use of BMI and the categories used here. Others have indicated that, at least for developed countries, information on BMI, waist circumference or waist-to-hip ratio do not necessarily improve prediction of mortality due to cardiovascular disease when information on systolic blood pressure, diabetes status and lipids are available [59]. Others argue, however, that waist circumference and waist-to-hip ratio can be useful in addition to BMI to better understand mortality risks [60, 61]. In Brazil, as in other developing countries, data on blood pressure and lipids is often lacking, so the use of anthropometric measures such as waist circumference may improve the understanding of the impact of changes in body composition on mortality and disability. We acknowledge this limitation and our analyses are constrained by these decisions. Third, the first wave of SABE focuses on the civilian population not residing in institutions. As a result, estimates may be biased if one expects that institutionalized individuals, particularly those residing in nursing homes, are likely to have a higher prevalence of disability than the non-institutionalized population. However, the institutionalized population in Brazil is relatively small [62], and therefore, this bias is likely to be small.

This study confirms previous studies that obesity is associated with increased disability in Brazilian older adults. Historically, Brazil was mainly concerned in curbing malnutrition; however, in recent years, new policies have aimed at controlling the marketing of highly processed and unhealthy foods [5]. Owing to the fact that obesity rates in Brazil has been increasing drastically for the past three decades [8], our findings have important implications for policy makers in Brazil to curb disability risk by promoting the use of effective preventive measures to reduce body weight and make healthy aging a reality.

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Table 1: Prevalence of ADL limitations, IADL limitations and Nagi limitations, by sex and BMI categories, São Paulo, 2000

	Total	**Underweight**	**Normal**	**Overweight**	**Obese**	**p-value**
Total	**n=1790**	**n=66**	**n=650**	**n=697**	**n=377**	
ADL	16.8	20.7	14.0	15.2	23.4	<0.001
IADL	24.5	49.4	23.4	22.3	26.8	<0.001
Nagi	57.9	63.5	49.5	55.3	74.9	<0.001
Females	**n=1066**	**n=32**	**n=320**	**n=407**	**n=305**	
ADL	19.8	22.2	14.6	19.4	25.4	<0.001
IADL	30.5	63.3	30.0	28.9	30.4	<0.001
Nagi	67.2	69.3	56.0	67.5	78.3	<0.001
Males	**n=727**	**n=34**	**n=330**	**n=290**	**n=72**	
ADL	12.3	19.0	13.5	9.8	15.7	<0.001
IADL	15.6	33.9	16.4	14.1	12.7	<0.001
Nagi	44.1	57.1	42.7	39.9	61.8	<0.001

Note: *** P<0.001

Table 2: Relative risk ratios of the impact of BMI categories on health transitions, São Paulo, Brazil - 2000-2006

	ADL			IADL			NAGI		
Variables	RRR	95% $CI		RRR	95% CI		RRR	95% CI	
Incidence of disability									
BMI categories									
Underweight	1.56	[0.52,4.69]		3.31	[0.97,11.27]		4.41	[0.67,29.16]	
Overweight	1.30	[0.83,2.03]		1.02	[0.66,1.58]		1.24	[0.74,2.06]	
Obese	2.78	[1.74,4.43]	***	2.15	[1.38,3.36]	**	1.35	[0.71,2.56]	
Age	1.10	[1.07,1.13]	***	1.10	[1.08,1.13]	***	1.05	[1.01,1.08]	**
Female	2.03	[1.29,3.20]	**	1.58	[0.92,2.71]		2.44	[1.43,4.16]	**
Remained with disability									
BMI categories									
Underweight	1.59	[0.14,17.48]		4.05	[1.08,15.19]	*	6.72	[1.31,34.54]	*
Overweight	1.37	[0.71,2.64]		1.44	[0.87,2.37]		1.77	[1.07,2.92]	*
Obese	3.66	[1.69,7.94]	**	2.18	[1.36,3.49]	**	3.96	[2.13,7.34]	***
Age	1.09	[1.05,1.13]	***	1.16	[1.13,1.19]	***	1.09	[1.06,1.12]	***
Female	2.71	[1.40,5.26]	**	3.32	[1.76,6.27]	***	4.79	[3.05,7.51]	***
Recovered from disability									
BMI categories									
Underweight	0.58	[0.11,3.11]		6.55	[0.60,71.84]		0.00	[0.00,0.00]	***
Overweight	1.64	[0.80,3.38]		1.57	[0.54,4.56]		1.43	[0.76,2.68]	
Obese	2.04	[0.97,4.30]		2.20	[0.70,6.95]		1.66	[0.66,4.19]	
Age	1.01	[0.97,1.05]		1.07	[1.01,1.14]	*	1.05	[1.00,1.09]	*
Female	1.90	[0.95,3.81]		1.38	[0.64,2.98]		2.65	[1.31,5.34]	**
Mortality									
BMI categories									
Underweight	0.89	[0.22,3.64]		1.79	[0.36,8.76]		3.19	[0.43,23.78]	
Overweight	0.82	[0.55,1.23]		0.82	[0.54,1.23]		1.03	[0.61,1.76]	
Obese	1.31	[0.84,2.04]		1.31	[0.82,2.09]		2.15	[1.05,4.38]	*
Age	1.14	[1.11,1.17]	***	1.18	[1.15,1.21]	***	1.17	[1.14,1.21]	***
Female	0.78	[0.53,1.14]		0.85	[0.57,1.28]		1.68	[1.09,2.59]	*
Lost to follow up									
BMI categories									
Underweight	0.89	[0.22,3.64]		1.79	[0.36,8.76]		3.19	[0.43,23.78]	
Overweight	0.82	[0.55,1.23]		0.82	[0.54,1.23]		1.03	[0.61,1.76]	
Obese	1.31	[0.84,2.04]		1.31	[0.82,2.09]		2.15	[1.05,4.38]	*
Age	1.04	[1.02,1.07]	***	1.08	[1.05,1.10]	***	1.07	[1.04,1.10]	***
Female	1.50	[1.11,2.03]	**	1.63	[1.18,2.24]	**	3.24	[2.19,4.79]	***

Note: *** P<0.001, **P<0.05; *P<0.10. Remaining free of disability is the baseline category. Normal weight is the baseline category for BMI. Analyses included smoking status.

Table 3: Relative risk ratios of the impact of BMI categories and BMI changes on health transitions, São Paulo, Brazil - 2000-2006

	ADL			IADL			NAGI		
Variables	RRR	95% $CI		RRR	95% CI		RRR	95% CI	
Incidence of disability									
BMI categories									
Underweight	0.82	[0.21,3.18]		2.20	[0.66,7.29]		4.02	[0.53,30.54]	
Overweight	1.40	[0.91,2.16]		1.05	[0.67,1.66]		1.35	[0.78,2.32]	
Obese	3.05	[1.85,5.03]	***	2.21	[1.41,3.45]	***	1.47	[0.75,2.86]	
BMI change									
Loss	1.17	[0.74,1.83]		1.01	[0.65,1.58]		0.86	[0.51,1.47]	
Gain	2.30	[1.11,4.77]	*	2.07	[1.05,4.10]	*	2.26	[1.28,3.97]	**
Age	1.10	[1.07,1.13]	***	1.11	[1.08,1.15]	***	1.05	[1.01,1.08]	*
Female	2.12	[1.31,3.44]	**	1.67	[0.95,2.92]		2.57	[1.54,4.27]	***
Remained with disability									
BMI categories									
Underweight	1.18	[0.09,15.19]		2.23	[0.59,8.50]		5.42	[0.97,30.41]	
Overweight	1.20	[0.61,2.34]		1.48	[0.86,2.57]		1.81	[1.09,3.00]	*
Obese	3.51	[1.48,8.34]	**	2.15	[1.25,3.71]	**	3.89	[2.05,7.38]	***
BMI change									
Loss	1.27	[0.72,2.25]		1.39	[0.90,2.14]		1.10	[0.68,1.79]	
Gain	2.01	[0.99,4.08]		1.59	[0.72,3.49]		1.75	[1.04,2.94]	*
Age	1.09	[1.05,1.13]	***	1.17	[1.13,1.20]	***	1.09	[1.05,1.12]	***
Female	2.95	[1.41,6.16]	**	4.00	[1.90,8.42]	***	5.10	[3.12,8.33]	***
Recovered from disability									
BMI categories									
Underweight	0.58	[0.10,3.39]		5.26	[0.52,53.30]		0.00	[0.00,0.00]	***
Overweight	1.46	[0.71,2.98]		1.64	[0.57,4.69]		1.49	[0.80,2.77]	
Obese	1.94	[0.93,4.03]		2.22	[0.68,7.21]		1.61	[0.65,3.98]	
BMI change									
Loss	1.06	[0.55,2.04]		0.85	[0.32,2.26]		1.26	[0.62,2.54]	
Gain	0.79	[0.29,2.17]		1.27	[0.37,4.33]		1.04	[0.34,3.20]	
Age	1.01	[0.97,1.06]		1.08	[1.01,1.15]	*	1.05	[1.00,1.09]	*
Female	1.75	[0.86,3.58]		1.45	[0.67,3.16]		2.76	[1.32,5.80]	**

Note: *** P<0.001, **P<0.05; *P<0.10. Remaining free of disability is the baseline category. Normal weight is the baseline category for BMI. Stable weight is the baseline category for weight change. Results for lost in the follow-up were omitted. All analyses included smoking status.