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Differences in disability and nutritional status among older Brazilian and English adults: the ELSI-Brazil and ELSA cohorts

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List of abbreviations

Activities of Daily Living (ADL)

Body Mass Index (BMI)

Brazilian Longitudinal Study of Ageing (ELSI-Brazil)

English Longitudinal Study of Ageing (ELSA)

Height in meters squared (kg/m^2)

Multicentre Research Ethics Committee (MREC)

Odds Ratio (OR)

World Health Organization (WHO)’s

95% Confidence Intervals (95% CI)

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"Data described in the manuscript, code book, and analytical coding will be made publicly and freely available without restriction at [http://elsi.cpqrr.fiocruz.br] and [https://www.elsa-project.ac.uk].".

Abstract

Background: Brazil and England are two countries at different stages on their demographic, epidemiological and nutritional transitions and with distinct socioeconomic and politic contexts, but with similar universal health systems. We aimed to examine disability and its association with objective anthropometric indicators of nutritional status, including Body Mass Index (BMI), waist circumference and waist-to-height ratio, comparing older Brazilian and English adults.

Methods: We used cross-sectional data from two nationally representative aging studies. For Brazil, we included 9,412 participants who participated in the baseline (2015-16) of the Brazilian Longitudinal Study of Ageing (ELSI-Brazil). The English data were from 8,024 participants of the wave 6 (2012-13) of the English Longitudinal Study of Ageing (ELSA). Disability was defined as a difficulty to perform at least one activity of daily living. We used logistic regression models to examine the association between anthropometric indicators and disability, adjusted for sociodemographic and health-related characteristics, considering the interaction term between each anthropometric indicator and country.

Results: All health-related characteristics were worse in Brazil than England, although the prevalence of disability was similar among Brazilian (17.85%) and English older adults (16.27%). Fully adjusted models showed statistically significant interaction terms between country and anthropometric indicators. The strength of the associations in Brazil were weaker compared to England. All anthropometric indicators were positively associated with disability: elevated BMI, (Odds ratio [OR]=1.27;95% CI 1.06, 1.51) in Brazil and (OR=1.80; 95% CI 1.51, 2.14) in England; elevated waist circumference, (OR=1.21; 95% CI 1.02, 1.44) in Brazil and (OR=1.90; 95% CI 1.51, 2.37) in England; and elevated waist-to-height ratio, (OR=1.20; 95% CI 0.96, 1.52) in Brazil and (OR=1.83; 95% CI 1.37, 2.44) in England.

Conclusions: Elevated BMI and waist circumference increased the odds of disability in both populations. However, these associations were stronger in England than Brazil.

Key words: Aging; Anthropometry; Body mass index; Activities of daily living; Waist circumference.

1. Introduction

The United Nations data show that, nationally, population aging has been occurring worldwide. According to official data, in 2019, the population aged 65 years and over was 10.8% in Brazil (http://www.ibge.gov.br) and 18.4% in England (http:// www.ons.gov.uk). Population projections estimate two billion people aged 60 years and over until the middle of this century. Of those, 80% will live in low and middle-income countries (1), showing that the aging process is not homogeneous. For example, it occurred gradually in high-income countries, such as England (2). On the other hand, in low and middle-income countries, such as Brazil, the aging process has been happening at a fast rate, leading to a shorter time for planning and changing public policies towards the elderly (3).

These differences result in even more challenges to achieve well-being later in life in Brazil (4), a country marked by higher socioeconomic inequalities (2). In 2015, the GINI index for the United Kingdom was 33.2% compared to 51.3% in Brazil (2). However, the health care systems of Brazil and England are universal and primary care orientated [ref], firstly implemented in England (1948) than in Brazil (1988). These differences provide a rare opportunity to compare a Western middle-income and an European high-income country, that present very distinct socioeconomic and epidemiological contexts and differently stages on their demographic transitions and public system implementation.

Nevertheless, few studies compared health indicators between these two countries, showing worse mortality (5), self-rated health, mobility limitation and disability in Brazil (6). In previous comparisons using nationally representative samples, Brazilians had a higher prevalence of Activities of Daily Living (ADL) disability than their English counterparts for one or more difficulties in performing ADLs (10.7% and 9.7%, respectively) and two or more ADLs (36.5% and 23.2%, respectively) (6). Later in life, disability negatively impacts the quality of life and has been reported to be a major predictor of mortality (7). Therefore, preventing or delaying disability might positively influence successful aging (8). However, aging is a dynamic process leading to significant musculoskeletal changes affecting nutritional status, body composition [4] and increased disability risk (3).

Some studies have showed positive associations between worse nutritional status, assessed by anthropometric indicators, and ADL disability (9–11), in which overweight gradually increases disability at older ages (12). Longitudinal studies conducted in European (10,11) and Brazilian (13) cities confirmed these findings. However, most of these studies used only BMI as the anthropometric indicator of nutritional status.

Therefore, we used cross-sectional data from two methodologically comparable and nationally representative aging studies in Brazil and England to examine disability and its association with objective anthropometric indicators of nutritional status in older adults. To the best of our knowledge, this is the first time that anthropometric indicators, including BMI, waist circumference and waist-to-height ratio, were compared across these two countries. We hypothesized that the relationship between elevated anthropometric indicators and disability is stronger in older Brazilian adults compared to older English adults.

2. Material and methods

Data source and design

This cross-sectional analysis was based on data from Brazil and England. Data from Brazil were extracted from the baseline of the ELSI-Brazil, conducted in 2015-16. It is a nationally representative, population-based cohort study of community-dwelling individuals aged 50 years and over, aiming to investigate determinants of the aging process in a country in rapid demographic aging, poor resources, and great social inequalities. The study used a probabilistic complex sample clustered in strata, according to the population size and households. ELSI-Brazil's sampling design and procedures were previously described in details (14). Briefly, a probabilistic complex sample design, which applied a sampling procedure combining geographical stratification and a three-stage clustering, was conducted. The final sample comprised of 9,412 older adults from 70 municipalities from the five great geographical regions of Brazil (Supplementary Figure 1). ELSI-Brazil followed the standards set by the Declaration of Helsinki and was approved by the ethics board of the Oswaldo Cruz Foundation, Minas Gerais (protocol 34649814.3.0000.5091). All participants signed an informed consent form.

For England, data were extracted from the ELSA, an ongoing panel study of a representative cohort of men and women living in England aged ≥50 years (15). It was designed as a sister study to the Health and Retirement Study in the USA and is multidisciplinary in orientation, involving the collection of economic, social, psychological, cognitive, health, biological and genetic data. The study commenced in 2002, and the sample has been followed up every 2 years. Data are collected using computer-assisted personal interviews and self-completion questionnaires, with additional nurse visits for the assessment of biomarkers every 4 years. More information on the study design and sampling procedures was previously published (15). All 8,024 ELSA participants who took part in the nurse visit (i.e. physical examination) at wave 6 (2012-13) were included in this analysis (Supplementary Figure 1). Wave 6 was used for this analysis because it is the closest wave to the year of ELSI's baseline and it had a nurse visit that collected data on the anthropometric indicators of nutritional status, including BMI and waist circumference. The ELSA was approved by the London Multicentre Research Ethics Committee (MREC/01/2/91).

Outcome

The outcome of interest was disability, measured by participants' self-reports of any difficulty in walking, transferring, toileting, bathing, dressing and eating using the modified

Katz Index (16). In Brazil, the participants were asked to rate their performance on each activity using a Likert scale (1 = no difficulty, 2 = little difficulty, 3 = great difficulty or 4 = unable to perform), whereas in England it was a dichotomous variable (1 = no difficulty, 2 = any difficulty). To maintain comparability between the two countries, disability was classified as "no" when the participants reported no difficulty to perform any of the six activities, and classified as "yes" when the participants reported little or great difficulty or unable to perform at least one of the six activities.

Anthropometric indicators of nutritional status

The independent target variables were the anthropometric measures of nutritional status, including BMI, waist circumference and waist-to-height ratio. In both cohorts, the anthropometric measures were assessed using similar procedures, i.e. participant wearing soft clothes and barefoot, following standard procedures. The BMI was calculated dividing weight in kilograms by height in meters squared (kg/m^2). Weight was measured using a calibrated electronic portable scale and height was measured by a portable stadiometer. We created groups classified according to the recommended BMI by age. For those aged up to 60 years, "low BMI" ($<18.5\ kg/m^2$), "adequate" (18.5 a $24.9\ kg/m^2$) and "elevated BMI" ($>24.9\ kg/m^2$) were based on the World Health Organization (WHO)'s criteria (17). For those aged 60 years and over, "low BMI" ($<22.0\ kg/m^2$), "adequate" (22.0 a $27.0\ kg/m^2$) and "elevated BMI" ($>27.0\ kg/m^2$) groups were based on the Lipschitz's criteria (18). Waist circumference was measured with an inextensible metric tape positioned at the midpoint between the last rib and iliac crest with the participant standing, arms alongside the body, trunk bare and during the expiratory phase (19) (20) and dichotomized as recommended by WHO (17) in "adequate" (<80 cm for women and <94 cm for men) or "elevated" (≥80 cm for women and ≥94 cm for men). The waist-to-height ratio was obtained by dividing the measured waist (cm) by the measured height (cm) and further dichotomized into “adequate” (<0.5) or “elevated” (≥0.5) (21). We have also used the anthropometric indicators as continuous variables to plot the graphs.

Potential confounding variables

We included sociodemographic and health-related characteristics that have been consistently associated with both disability and nutritional status (22,23).

- *Sociodemographic characteristics:* sex (female and male); age (continuous); marital status (living with a partner or not living with a partner, i.e. single, widowed or divorced); and education, in complete years of schooling. In Brazil, formal education is organized into first level (1–8 schooling years), second level (9–11 years) and higher. We categorized years of education as incomplete first level (<8 years), complete first level up to incomplete second level (8–10 years) and complete second level or higher (≥ 11 years). We used the English educational categories 0 level or equivalent (≤ 11 years of school), lower than A or equivalent (12–13 years), and higher (≥ 14 years) (6).

- *Health-related characteristics:* smoking status (yes or no); physical activity measured using the short version of the International Physical Activity Questionnaire (24) (sedentary or active according to the time spent on walking, moderate activities and vigorous activities) (25); self-rated health (excellent/very good or good, fair, bad/very bad); number of chronic conditions, including self-reported medical diagnosed hypertension, diabetes, depression, cancer, arthritis or rheumatism, high cholesterol, stroke and cardiovascular disease (0, 1 or 2+).

Statistical analyses

- *Adjusted prevalence rates:* First, age- and sex-adjusted prevalence rates were calculated for each indicator for each country using the standard population at the individual-level by the directly standardized method to allow the comparison of the prevalence rates between the two countries.

- *Univariate models:* Second, we used logistic regression to estimate the OR and their 95% Confidence Intervals (95% CI) to examine the association between anthropometric indicators and ADL disability, considering the interaction term between each anthropometric indicator and country. The crude OR for each anthropometric indicator i.e. BMI, waist circumference and waist-to-height ratio was obtained by univariate models.

- *Multivariate models*:

The adjustments in the sequential models were done as follows: (1) sociodemographic characteristics, including sex, age, marital status and education (Model 1); (2) health-related characteristics, including smoking status, physical activity, self-rated health, and number of chronic conditions (Model 2) and, finally, (3) Models 1 and 2 together (fully adjusted model). Adjusted multivariate analysis was performed separately for each anthropometric indicator. Next, we splited the OR of the association between anthropometric indicators of nutritional status and disability by country, considering the OR of the interaction obtained from the fully adjusted model.

Considering the distinct sampling designs of ELSI-Brazil and ELSA studies, our analyses incorporated only each survey's probability individual weights to facilitate the joint analyses of both countries' data. All analyses were performed using STATA software (Stata Corp., College Station, United States), version 13.0 and accounted for the survey weights.

3. Results

Considering a statistically significant difference in age between England and Brazil (mean age 64.4 ± 9.7 years *vs* 62 ± 10.4 years, respectively), and a lower prevalence of women (23.4% *vs* 29.9%, respectively), age- and sex-adjusted prevalence rates were calculated for each anthropometric indicator for each country for the descriptive analysis. Missing data were similar between countries (p=0.76), comprising of 470 participants from England and 541 from Brazil. Those who had missing data tended to be older and to belong to the lowest education group (p<0.001). As reported in Table 1, the prevalence of disability was similar among older Brazilian adults (17.85%) compared to their English counterparts (16.27%).

Most of the participants had elevated anthropometric indicators. Elevated BMI: 57.5% in Brazil and 60.15% in England; elevated waist circumference: 70.22% and 77.23%, respectively; and elevated waist-to-height ratio: 87.46% and 83.6%, respectively. We found statistically significant differences among all anthropometric indicators of nutritional status between countries. Some indicators were higher in England (elevated BMI and elevated waist circumference), while others in Brazil (low BMI and elevated waist-to-height ratio). The highest country difference found was for high waist circumference (7.01%), followed by a low BMI (3.95%). All health-related characteristics were worst in Brazil. We found higher differences between countries for self-rated health (27.26%) and the presence of two or more chronic conditions (16.08%) (Table 1). Considering the chronic conditions, hypertension was the most frequent (61.4%), followed by high cholesterol (42.9%) and arthritis or rheumatism (38%) (data not shown).

[Table 1 near here]

Table 2 shows the logistic regression results between disability and anthropometric indicators. Regarding the BMI, we found a significant association with disability after adjustments. The odds of disability was higher among older adults with elevated BMI compared to older adults with adequate BMI. The statistically significant interaction term between BMI and country (OR=0.70; 95% CI 0.55, 0.90) shows a different strength of the association by country i.e. lower in Brazil than England.

[Table 2 near here]

Waist circumference was independently and significantly associated with disability. The significant interaction terms between waist circumference and country (OR=0.64; 95% CI 0.48, 0.85) and waist height-ratio and country (OR=0.66; 95% CI 0.46, 0.95) found in the fully adjusted models show a different strength of the association by country, weaker in Brazil than England.

The reported OR presented in Table 2 cannot be interpreted directly since the country interactions were statistically significant. Therefore, we split the OR of the association between anthropometric indicators of nutritional status and disability by country, considering the odds ratio of the interaction obtained from the fully adjusted model.

The split OR are presented in Table 3. The results show higher odds of disability when the participants had either high BMI or high waist circumference in both Brazil and England. These associations were strengthened among older English adults than Brazilians for both high BMI (OR=1.80; 95% CI 1.51, 2.14; and OR=1.27; 95% CI 1.06, 1.51, respectively) and high waist circumference (OR=1.90; 95% CI 1.51, 2.37; and OR=1.21; 95% CI 1.02, 1.44, respectively). However, significant higher odds of disability were observed only among older English adults (OR=1.83; 95% CI 1.37, 2.44) for waist-height ratio.

[Table 3 near here]

4. Discussion

Our main findings were that older adults with elevated BMI and elevated waist circumference were more likely to have an ADL disability in both Brazil and England. These associations were stronger among English older adults. Considering the waist-to-height ratio, the association with ADL disability was significant only among older English adults.

BMI has been considered an adequate anthropometric indicator, due to its easy assessment, comparability between different populations and strong association with body fat, regardless of changes in body composition related to aging (26). Nevertheless, some aging related changes that potentially modify BMI might be masked, such as decreased weight, height, muscle mass and the enlargement of visceral fat (27). Therefore, the Food and Nutrition Surveillance System has recommended higher cutoffs for older adults (28), similar to the ones proposed by Lipschitz (18).

Vlassopoulos et al. (29) showed that waist circumference tends to increase after the age of 65 years. Nearly 30% of men and 55% of women with adequate BMI (according to the World Health Organization's criteria) show elevated waist circumference. Therefore, BMI should ideally be used in combination with waist circumference to correctly assess abdominal fat. The waist-to-height ratio has also been used to estimate visceral fat. Both measures are more sensitive than BMI and superior to predict cardiometabolic risk (21).

In the present study, we observed significant differences in the anthropometric indicators by country i.e. 57.50% of Brazilians *vs* 60.15% of English were classified with elevated BMI, whereas elevated waist circumference (70.22% of Brazilians *vs* 77.23% of English) and elevated waist-to-height ratio (87.48% of Brazilians *vs* 83.60% of English) were also prevalent. Our results corroborate with a previous comparison between England and Brazil, where obesity was more prevalent among English (27.1% versus 17%) (30) and found that waist circumference and waist-to-height ratio were more specific indicators of abdominal fat than BMI.

Differently from previous studies (3,31), we did not find any difference between low BMI and adequate BMI and the odds of ADL disability. Underweight is one of the main determinants of physical performance via lean mass reduction and, consequently, lower muscle strength (8). Lower muscle strength has also been associated with ADL disability, primarily eating difficulties leading to undernutrition (32). According to longitudinal studies, underweight has been associated with disability onset among Brazilians (13,33) and Americans (34,35).

With regards to the positive association between elevated BMI and ADL disability, our findings corroborated those from previous longitudinal studies (36) (37), showing that this association is stronger among older English adults than older Brazilian adults. Moreover, overweight was associated with disability onset among older Brazilians (33) and older Americans (34,35).

Importantly, abdominal fat, assessed by waist circumference and waist-to-height ratio, reduces muscle strength, and contributes to worse disability trajectories (39), corroborating with our findings. Visceral fat is a highly metabolic active endocrine organ that secretes pro-inflammatory cytokines and adipokines. They are relevant for immune-modulation, energy balance, and fatty acid and glucose metabolism, all of which suffer dysregulation with increasing abdominal obesity (40) related to aging.

Prior studies also have found an association between waist circumference and disability in different countries (3,37,41) and Brazil (42). Another study comparing older English and Brazilians also found that abdominal obesity was longitudinally associated with functional decline (43). Regarding the association between waist-to-height ratio and disability, our results showed that older English adults with elevated waist-to-height ratio were 1.83 times more likely to have ADL disability, whereas among older Brazilians this association was not found.

Differently from our initial hypothesis, the impact of anthropometric indicators on disability was higher among English than Brazilians. Despite the fact that the physiological link between visceral fat and disability is the same for all individuals (39,40), our results showed that individual characteristics do not explain all disability spectrum. We included a wide range of potential confounders in our analyses such as sociodemographic and health-related characteristics, however, socioeconomic inequalities may persist. The differences found in the sociodemographic profile and health conditions between English and Brazilian participants might be partially explained by country-income differences, such as inequalities in health care access, lower health professional density and lower per capita health expenditure (6). For example, the expected probability of two or more ADL limitations among English individuals with the lower education level is similar to Brazilians with the highest education level (6). However, in Brazil, inequalities in ADL disability are primarily explained by socioeconomic status (wealth and own education, summing 92%), not by demographic or health factors (44). Moreover, we cannot ignore that Brazil, according to official recent statistics, currently shows nearly a four-fold larger population than England, increasing the demand to their health care system.

The main limitation of the present study relates to its cross-sectional design that prevent us from establishing causality between nutritional status and disability, despite some longitudinal studies indicating temporality (10,11,13,35–37,41–43). However, due to the lack of anthropometric indicators in some waves, data from ELSA (2012-2013) and ELSI-Brazil (2015-2016) analyzed in this study came from distinct years and could have influenced our results. Lastly, although we considered the sample weights from the two cohorts, the complexity of the ELSI-Brazil sampling design was not taken into account in our analyses.

This study has some strengths that should be acknowledged. Firstly, it was conducted with a large, diverse, and nationally representative sample of older adults living in Brazil and

England using comparable methodologies, which allowed us to investigate differences in the impact of anthropometric indicators on disability. Although the ELSA data have been widely used, it was the first time that ELSA was compared to ELSI-Brazil to address the present research question. Secondly, we have used simple and easy to interpret standardized anthropometric indicators that have a broad potential to be used in both clinical settings and primary health care. Although Brazil and England present similar universal health systems (i.e. primary health care orientated), low- and middle-income countries show limited resources and would benefit more from cost-effectiveness methods. Thirdly, the analyses were adjusted for a wide range of relevant confounders, minimizing the probability of residual confounding.

Conclusion

Elevated anthropometric indicators of nutritional status, including BMI and waist circumference, increase ADL disability in older Brazilian and English adults. However, these associations were stronger among ELSA participants. The waist-to-height ratio was associated with ADL disability only in English participants. Our findings highlight the need for assessing BMI associated with other abdominal obesity indicators during the evaluation of older adults by health professionals. Keeping adequate values of these simple modifiable measures might potentially decrease or even prevent the impact of disability in high-, middle and low-income countries and promote successful aging.

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Statement of Authorship

The specific responsibilities of were the following - MFLC, FBA and CO designed research; NTMY, JLT, MFLC and CO conducted research; NTMY, JLT, MFLC, JVMM and FBA analyzed data; NTMY, CO, JVMM, FBA, JLT and MFLC wrote the paper; NTMY, CO, JVMM, FBA, JLT and MFLC had primary responsibility for final content. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors have declared that no competing interests exist.

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Tables

Table 1 – Age- and sex-adjusted prevalence of anthropometric indicators, sociodemographic and health-related characteristics in older Brazilian and English adults – ELSI-Brazil (2015-16) and ELSA (2012-13).

	Brazil	**England**	***Difference***
	% (95% CI)[a]	**% (95% CI)[a]**	***%***
Disability [b]	17.85 (17.07, 18.63)	16.27 (15.46, 17.07)	1.58
Body Mass Index [c]			
Adequate	33.12 (32.13, 34.12)	34.10 (33.0, 35.19)	0.98
Low	9.37 (8.73, 10.01)	5.42 (4.95, 5.89)	3.95*
Elevated	57.50 (56.49, 58.52)	60.15 (59.03, 61.27)	2.65*
Waist circumference [d]			
Adequate	29.78 (28.87, 30.7)	22.43 (21.45, 23.41)	7.35*
Elevated	70.22 (69.30, 71.13)	77.23 (76.25, 78.22)	7.01*
Waist-to-height ratio [e]			
Adequate	12.53 (11.85, 13.23)	16.08 (15.21, 16.95)	3.55*
Elevated	87.46 (86.77, 88.15)	83.60 (82.73, 84.47)	3.86*
Sociodemographic characteristics			
Living with a partner [f]	56.92 (55.97, 57.87)	65.96 (64.90, 67.02)	9.04*
8-10 years of education [g]	10.31 (9.70, 10.92)	28.82 (27.77, 29.87)	18.51*
< 8 years of education [g]	69.31 (68.40, 70.23)	32.50 (31.42, 33.58)	36.81*
Health-related characteristics			
Current smoker [h]	16.43 (15.69, 17.18)	12.57 (11.78, 13.36)	3.86*
Physically active	53.84 (52.83, 54.86)	66.77 (65.73, 67.80)	12.93*
Fair self-rated health [i]	45.64 (44.61, 46.68)	18.38 (17.52, 19.24)	27.26*
Poor/very poor self-rated health [i]	12.42 (11.73, 13.11)	7.40 (6.81, 7.99)	5.02*

One chronic condition [j]	28.53 (27.60, 29.46)	26.71 (25.75, 27.67)	1.82
2+ chronic conditions [j]	50.42 (49.41, 51.43)	34.34 (33.40, 35.28)	16.08*
N total	9,412	8,024	

Note. 95% CI: 95% Confidence Interval.[1]Age- and Gender-Adjusted Prevalence based on the directly standardized method. Missing data: [b] 1, [c] 798, [d] 549, [e] 777, [f] 1, [g] 103, [h] 2, [i] 24. [j] Considering hypertension, diabetes, depression, cancer, arthritis or rheumatism, high cholesterol, stroke and cardiovascular disease * p<0.05

Table 2 – Uni and multivariate association between the anthropometric indicators of nutritional status and disability: ELSI-Brazil (2015-2016) and ELSA (2012-2013).

	Disability			
	Crude analysis OR (95% CI)	**Model 1 OR (95% CI)**	**Model 2 OR (95% CI)**	**Fully adjusted Model OR (95% CI)**
Body Mass Index (BMI) (vs adequate)				
Low	1.39 (1.01, 1.94)*	1.15 (0.83, 1.62)	1.06 (0.72, 1.54)	0.96 (0.65, 1.40)
Elevated	1.99 (1.69, 2.36)*	2.19 (1.87, 2.62)*	1.66 (1.39, 1.97)*	1.80 (1.52, 2.14)*
Country (vs England)				
Brazil	1.21 (1.01, 1.47)*	1.27 (1.04, 1.54)*	0.64 (0.52, 0.79)*	0.69 (0.55, 0.86)*
Interaction (vs England)				
Low BMI in Brazil	1.08 (0.71, 1.64)	1.05 (0.68, 1.62)	1.34 (0.84, 2.13)	1.29 (0.80, 2.06)
Elevated BMI in Brazil	0.63 (0.50, 0.79)*	0.64 (0.51, 0.80)*	0.71 (0.55, 0.90)*	0.70 (0.55, 0.90)*
Waist Circumference (WC) (vs adequate)				
Elevated	2.43 (1.97, 2.99)*	2.38 (1.93, 2.94)*	1.83 (1.47, 2.29)*	1.90 (1.51, 2.37)*
Country (vs England)				
Brazil	1.42 (1.12, 1.80)*	1.49 (1.17, 1.89)*	0.74 (0.57, 0.95)*	0.80 (0.61, 1.04)

Interaction (vs England)				
Elevated WC *in* Brazil	0.57 (0.44, 0.74)*	0.57 (0.44, 0.74)*	0.65 (0.49, 0.86)*	0.64 (0.48, 0.85)*
Waist-to-Height ratio (WtHr) (vs adequate)				
Elevated	2.53 (1.96, 3.28)*	2.51 (1.93, 3.27)*	1.75 (1.32, 2.32)*	1.83 (1.37, 2.44)*
Country (vs England)				
Brazil	1.52 (1.10, 2.10)*	1.60 (1.15, 2.23)*	0.72 (0.51, 1.02)	0.79 (0.56, 1.13)
Interaction (vs England)				
Elevated WtHr *in* Brazil	0.56 (0.39, 0.78)*	0.54 (0.38, 0.77)*	0.69 (0.48, 0.98)*	0.66 (0.46, 0.95)*

Note: OR: Odds Ratio, based on the Logistic Regression models; 95% CI: 95% Confidence Interval. *p<0.05
Model 1: adjusted for sociodemographic characteristics (sex, age, marital status, and education). Model 2: adjusted for health-related characteristics (current smoking, physical activity, self-rated health, and number of chronic conditions). Fully adjusted Model: Model 1 + Model 2. N total of the fully adjusted models: BMI=16,024; WC=16,258; WtHr=16,041.

Table 3 – Split odds ratios of the association between the anthropometric indicators of nutritional status and disability by country, derived from the fully adjusted models: ELSI-Brazil (2015-16) and ELSA (2012-13).

	Brazil	**England**
	OR (95% CI)	**OR (95% CI)**
Body Mass Index		
Adequate	1.00	1.00
Low	1.23 (0.93, 1.62)	0.96 (0.65, 1.40)
Elevated	1.27 (1.06, 1.51)*	1.80 (1.51, 2.14)*
Waist circumference		
Adequate	1.00	1.00
Elevated	1.21 (1.02, 1.44)*	1.90 (1.51, 2.37)*
Waist-to-height ratio		
Adequate	1.00	1.00
Elevated	1.20 (0.96, 1.52)	1.83 (1.37, 2.44)*

Note. OR: Odds Ratio, based on the Logistic Regression models; 95% CI: 95% Confidence Interval. *p<0.05. Adjusted for sociodemographic characteristics (sex, age, marital status, and education), health-related characteristics (current smoking, physical activity, self-rated health, and number of chronic conditions).
N total of the fully adjusted models: Body Mass Index=16,024; Waist Circumference=16,258; Waist-to-height ratio=16,041.