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Social determinants, lifestyle and diet quality: a population-based study from the 2015 Health Survey of São Paulo, Brazil

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Abstract

Objective: To investigate the association among social determinants, lifestyle variables and diet quality in São Paulo, Brazil.

Design: Cross-sectional study, 2015 Health Survey of São Paulo (Inquérito de Saúde de São Paulo (2015 ISA-Capital)) with Focus on Nutrition Study (2015 ISA-Nutrition).

Setting: Population-based study, with a representative sample of adults living in São Paulo, Brazil.

Participants: Adults (aged 20–59 years, n 643) and older adults (aged ≥60 years, n 545).

Results: We observed differences in the Brazilian Healthy Eating Index-Revised (BHEI-R) by education, income, occupation, sex and race. Whole grains (0·63 points, 12·6 % of the maximum score), sodium (2·50 points, 25·0 %) and solid fat, alcohol and added sugars (9·28 points, 46·4 %) components had the lowest BHEI-R scores. Factors positively associated with diet quality included the presence of one disease or more (e.g. diabetes mellitus, hypertension, cancer, hypercholesterolaemia: $\beta = 0{\cdot}636$, $P < 0{\cdot}001$), income (middle income: $\beta = 0{\cdot}478$, $P < 0{\cdot}001$; high income: $\beta = 0{\cdot}966$, $P < 0{\cdot}001$) and occupation (other: $\beta = 1{\cdot}418$, $P < 0{\cdot}001$). Energy ($\beta = -0{\cdot}001$, $P < 0{\cdot}001$), alcohol consumption ($\beta = -0{\cdot}207$, $P = 0{\cdot}027$), education level (middle education: $\beta = -0{\cdot}975$, $P < 0{\cdot}001$; high education: $\beta = -1{\cdot}376$, $P < 0{\cdot}001$), races other than white ($\beta = -0{\cdot}366$, $P < 0{\cdot}001$) and being unemployed ($\beta = -0{\cdot}369$, $P < 0{\cdot}046$) were negatively associated with diet quality.

Conclusions: Groups affected by socio-economic inequalities need better diet quality. Governmental actions should be implemented to reduce the consumption of energy-dense and sodium-rich foods, facilitate access and information on healthy eating, and conduct nutritional education.

Keywords
Food consumption
Dietary intake
Diet quality
Social determinants
Inequalities

Individual lifestyle behaviours such as diet, smoking, alcohol consumption and physical activity can influence the health of populations and contribute to explain socio-economic inequalities in healthy lifestyles[1]. A worldwide diet quality assessment conducted in 187 countries evaluated the intake of several dietary items (foods and nutrients) in 1990 and 2010 and showed that women had better diet quality compared with men[2]. Evidence showed that populations living in high-income countries had better diet quality, but also had substantially increased intakes of foods containing high levels of nutrients of public health concern, namely added sugars, fats and sodium[2].

The WHO[3] defined a poor diet as one with low consumption of fruits and vegetables, legumes and whole grains, and with high intakes of saturated fats, sodium and added sugars. An unhealthy diet is associated with several health risk factors and conditions such as CVD, certain types of cancer, type 2 diabetes and bone diseases among

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adults and older adults[4–7] and increases the likelihood for premature mortality. Evidence[4–8] shows that an adequate diet has a protective role against developing these conditions.

While there are comprehensive efforts to promote healthier diets, health equity issues are often neglected[9]. This might be explained by the fact that many studies do not focus on structural social determinants of health (SDH), which play an important role in generating social stratification[9,10]. Structural SDH are termed 'social determinants of inequalities', since they are the ones that generate the most inequalities in health[10]. Therefore, healthy eating policies should consider the economic and social dimensions of different population groups.

Although these questions have been the subject of some research in Brazil[11–13], few studies have focused on comprehending and identifying differences in diet quality in distinct socio-economic groups. However, this knowledge is important in order to support specific and appropriate interventions in public health, as well as to establish comparisons between target populations and provide information on the aspects of diet that need improvement. The hypothesis of the present study is that individuals with high income, high education, white-collar occupation, white race and female sex will present better diet quality than low-income, low-education level, blue-collar occupation, races other than white and male individuals living in São Paulo, Brazil.

Therefore, the aim of the present study was to investigate the association between social determinants, lifestyle variables and diet quality in a population-based study with adults and older adults from São Paulo city, Brazil, in 2015.

Methods

2015 ISA-Capital overview

The 2015 Health Survey of São Paulo (Inquérito de Saúde de São Paulo (2015 ISA-Capital)) Focus on Nutrition Study (2015 ISA-Nutrition) is a cross-sectional survey conducted from February 2015 to February 2016 that used a multistage, stratified, area-probability sample of non-institutionalized individuals, stratified by clusters, urban census tracts and households, providing representative estimates of the population of São Paulo city[14]. An overview of the 2015 ISA-Capital including the purpose, design, sampling methods and data collection procedures, with a focus on dietary methods, has been published elsewhere[14]. In addition, the protocol describing the sub-sample of 2015 ISA-Nutrition with the analytical considerations and applicability has also been published elsewhere[15]. Data were collected using tablet computers and by filling out self-reported questionnaires separated by topic.

Study sample

The 2015 ISA-Capital was stratified into the five Health Coordinations of São Paulo: North, Central-West, Southeast, South and East, which were the domains of the study. In the first sampling stage, thirty urban census tracts were randomly selected from each geographical area for health assistance, totalling 150 primary sampling units from the municipality. In the second stage, an average of eighteen private households were systematically selected in each census tract. The number '18' corresponded to the highest value of the households calculated, considering that each demographic domain used to plan the sample included the geographical area for health assistance, district/sector and age group by sex (adolescents, aged 12–19 years; male adults, men aged 20–59 years; female adults, women aged 20–59 years; and older adults, aged ≥60 years). All individuals in the households who belonged to the selected demographic domains were invited to participate[14,15].

The study included 300 adolescents, 300 adults and 300 older adults. The number '300', by domain, allows for proportions estimation of 0·50, with a sampling error of 7 %, considering a 95 % confidence level and a design effect of 1·5[14]. Of those who agreed to participate (n 4059), 1737 individuals were randomly selected to be included in the 2015 ISA-Nutrition[14].

Data from 1188 adults and older adults participating in the sub-sample were included in the present study, resulting in a final sample of 643 adults aged 20–59 years and 545 older adults aged ≥60 years from both sexes living in urban areas in the city of São Paulo, Brazil. Socio-economic data and 24 h dietary recalls (24HR) were evaluated from the 2015 ISA-Capital. The 2015 ISA-Capital employs protocols and procedures that ensure confidentially and protect the identity of the participants[15].

Data collection

The 2015 ISA-Capital questionnaire is a self-report, semi-structured questionnaire divided into sixteen blocks and filled out using a tablet device. Data collection was conducted by trained interviewers who visited the selected households to conduct individual interviews based on the questionnaire in order to assess sociodemographic and lifestyle factors and BMI (using weight and height). Physical activity was assessed through the long version of the International Physical Activity Questionnaire (IPAQ) and mental health was assessed through the Self-Reporting Questionnaire (SRQ-20), both validated for the Brazilian population[16,17].

Social determinants (independent variables)

The SDH variables that were used to investigate associations with diet quality in the population were: sex, age (20–39 years, 40–59 years and ≥60 years), race (skin colour: white or races other than white), marital status (living with or without a partner), income status (a continuous variable in Brazilian currency (Real) converted into US dollars, level of income was described using tertiles: low, middle and high income status), education (a continuous variable in years, level of education was described using tertiles: low, middle and high), number of consumer goods[18] (refrigerator, freezer, water filter, microwave, dishwasher, washing machine, television, DVD player, air conditioning, vacuum cleaner, landline, cell phone, camera, motorcycle, bicycle and car) and occupation status (blue collar, white collar, unemployed and other, with the latter including students, housewives, retirees and pensioners).

Occupations used in the 2015 ISA-Capital were noted using the codes of the Brazilian Classification of Occupations[19], categorized into blue- and white-collar jobs. Blue-collar workers are individuals whose job requires manual labour, such as construction workers, drivers, plumbers and general services; and white-collar workers are individuals whose work may be performed in an office or other administrative setting, such as managers, salespeople, government workers, bankers, and physicians and other health-related occupations[19].

Health and lifestyle variables (other covariates)

Health variables included in the analysis were related to the following sub-categories: (i) use of health services (health care); (ii) referred diseases and deficiencies; (iii) use of medications; and (iv) mental health[17]. Health status variables included health insurance (yes or no), chronic diseases (presence or absence of the following diseases: hypertension, type 2 diabetes, hypercholesterolaemia and cancer), use of medications (yes or no), mental health (SRQ-20: positive or negative, with a cut-off point of 7 for women and 6 for men)[17], self-perception of health (excellent, good, very good, regular, bad, very bad) and nutritional status (non-overweight or overweight). The lifestyle variables were smoking (never smoked, former smoker or current smoker), alcohol consumption (yes or no) and physical activity in leisure time (meeting or not meeting the WHO global recommendation of ≥150 min/week)[20].

Anthropometric measures

Height and weight were measured in triplicate according to the procedures proposed by the WHO[21] and Brazilian Food and Nutrition Surveillance System[22]. BMI was calculated as body weight (in kilograms) divided by the square of height (in metres). The WHO[21] reference was used to determine weight status in adults[21,22]: underweight (BMI < 18·5 kg/m^2), normal weight (BMI = 18·5–24·99 kg/m^2), overweight (BMI = 25·0–29·99 kg/m^2) and obesity (BMI ≥ 30·0 kg/m^2). Older adults were classified according to the Pan American Health Organization[23], considering underweight as BMI ≤ 23·0 kg/m^2, normal weight as BMI = 23·0–27·99 kg/m^2, overweight as BMI = 28·0–29·99 kg/m^2 and obesity as BMI ≥ 30·0 kg/m^2.

Determination of dietary intake

Dietary intake data were obtained through one face-to-face and one telephone interview based on 24HR on two non-consecutive days using an automated multiple-pass method[24,25] considering all seasons of the year and all days of the week that contributed to daily variation in dietary intake[24]. The second 24HR was collected via telephone 185 d (median) after the first 24HR was recorded. For both 24HR, the participants were instructed to report their food consumption in household measures, as well as the preparation method, ingredients and trademarks of the food items in a standardized way to avoid possible bias.

The Nutrition Data System for Research (NDSR) software (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA) was used to compute data obtained by the 24HR. After entering the data, energy and nutrient intake values were checked to identify possible mistakes in data collection and entry. Each food and/or food preparation was inserted in the NDSR software using standardized measures in grams or millilitres[26,27]. The energy and nutrient values of all the foods were included in the database and estimated based on the Brazilian food composition table[28].

All 24HR data with an energy intake of ≤3347 kJ (≤800 kcal) and ≥16 736 kJ (≥4000 kcal) were verified in the database to avoid possible typos and biases[15,29]; if the data were correct, the individuals were not excluded. Dietary intake data were collected by trained interviewers in Portuguese language. Detailed description of the dietary interview methods is provided in the dietary interview procedure manual from ISA-Capital[29]. Based on the two 24HR, the usual intake was estimated by the Multiple Source Method[30], a statistical method that adjusts dietary data for within-person variability.

Assessment of dietary quality (outcome variable)

Overall diet quality was evaluated through the Brazilian Healthy Eating Index-Revised (BHEI-R; Portuguese acronym IQD-R)[31] and tested for validation and reproducibility[32]. The BHEI-R components and cut-off points were based on recommendations of the Dietary Guidelines for the Brazilian Population 2006[33], WHO, Institute of Medicine, Healthy Eating Index-2005 (HEI-2005) and Brazilian Society of Cardiology[31,32]. The BHEI-R evaluates a combination of different types of foods, nutrients and other components of the diet regarding the daily intake recommendations and/or health outcomes.

The BHEI-R comprises twelve components (nine food groups, two nutrients and the sum of energy from solid fat, alcohol and added sugar (SoFAAS)) that receive a minimum score of 0 points up to a maximum score of: (i) 5 points for total fruit, whole fruit, dark-green and orange vegetables and legumes (DGOV&L), total grains and whole

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grains; (ii) 10 points for milk and dairy, meats, eggs and legumes, oils (vegetable oils, seed oils and fish oils), saturated fat and sodium; or (iii) 20 points for SoFAAS[31]. Intermediate values were calculated proportionally to the amount consumed[31]. The overall score ranges from 0 (poor diet quality) to 100 (excellent diet quality).

Statistical analysis

All analyses were conducted using the 'survey' module of the statistical software package Stata version 13, considering design and sample weights. Descriptive statistics were performed using means and 95 % confidence intervals or frequencies and percentages, as appropriate.

A test of adherence to the normal distribution curve (Shapiro–Wilk) was performed for BHEI-R and its respective components, which all had a normal distribution. Total BHEI-R score and each component score were described as means and 95 % confidence intervals or as means with their standard errors. Differences between means were observed by the Wald test or ANOVA (descriptive level: $P < 0{\cdot}05$), adjusted for sex and age.

A bar graphic was created for each BHEI-R component score and the total score to identify the adherence of the population and propose actions focused on diet change.

The Wald test was applied (descriptive level: $P < 0{\cdot}05$) to identify differences between BHEI-R components according to SDH, adjusted for sex and age. Multiple linear regression was used to verify possible associations between the dependent variables (diet quality: BHEI-R) and independent variables (SDH and lifestyle variables), adjusted for potential confounding effects. $P < 0{\cdot}20$ was considered for inclusion in the (univariate) model and $P < 0{\cdot}05$ for the descriptive level. Interactions among the variables included in the final model were also tested for multicollinearity, but no significant values were found (all variance inflation factor values were lower than 10). A residual analysis was performed to test for homoscedasticity of errors in regression and no bias was found.

Results

Sociodemographic characteristics

Descriptive statistics and mean BHEI-R total score according to sociodemographic, economic, health and lifestyle variables are presented in Tables 1 and 2. A higher mean diet quality was found among individuals who were older, white, with low education level, in the other occupational category (students, housewives, retirees and pensioners), who had chronic non-communicable diseases, were medication users, non-smokers, non-alcohol users, who were low physically active and those self-reporting their health as regular, bad or very bad.

The BHEI-R components with the highest scores in 2015 were: oils (9·89 points or 98·9 % of the maximum score); total grains (4·86 points or 97·2 %); meats, eggs and legumes (9·43 points or 94·3 %); total vegetables (4·72 points or 94·4 %); DGOV&L (4·25 points or 85·0 %); total fruit (3·84 points or 76·8 %); whole fruit (3·53 points or 70·6 %); and saturated fat (7·24 points or 72·4 %; Fig. 1). The following components had adherence below 50 % for the mean consumption of BHEI-R reference values: whole grains (0·63 points or 12·6 %), sodium (2·50 points or 25·0 %) and SoFAAS (9·28 points or 46·4 %).

Table 3 shows means and their standard errors for overall diet quality and BHEI-R components according to the structural SDH, adjusted for sex and age. Individuals with low level of education had better mean scores for total and whole fruit, total vegetables and DGOV&L, whole grains, milk and dairy, saturated fat and SoFAAS, and better total BHEI-R score, compared with those with middle and higher education, who presented higher mean scores for oils and sodium compared with those with lower education. Low-income individuals presented higher mean scores for total grains, saturated fat and SoFAAS, while those with a high income presented higher mean scores for total fruit, whole fruit, total vegetables and SoFAAS.

White-collar workers had higher mean scores for whole grains, milk and dairy than blue-collar workers; and blue-collar workers presented higher mean scores for total vegetables and DGOV&L, total grains, meats, eggs and legumes, oils and saturated fat than white-collar workers. It should be noted that the individuals from the other category (retirees, pensioners, students and housewives) presented higher mean scores for total and whole fruit, total vegetables, whole grains, milk and dairy, and SoFAAS, and had better overall diet quality, compared with blue-collar workers.

Higher mean scores for total fruit, whole grains, milk and dairy, but lower mean scores for total vegetables and DGOV&L, total grains, meats, eggs and legumes, oils, saturated fat and SoFAAS, were observed in women than in men. Regarding skin colour, white race individuals had higher mean scores for total and whole fruit, total vegetables, whole grains, milk and dairy; and races other than white presented higher mean scores for total grains, meats, eggs and legumes, and oils (Table 3).

The results of the multiple linear regression analyses indicated positive associations between diet quality and the following categories: presence of chronic diseases ($\beta = 0{\cdot}636$, $P < 0{\cdot}001$), middle income ($\beta = 0{\cdot}478$, $P < 0{\cdot}001$), high income ($\beta = 0{\cdot}966$, $P < 0{\cdot}001$) and other occupation (e.g. retirees, pensioners, students and housewives; $\beta = 1{\cdot}418$, $P < 0{\cdot}001$). Negative associations were found between diet quality and higher mean energy (kcal) consumption ($\beta = -0{\cdot}001$, $P < 0{\cdot}001$), alcohol consumption ($\beta = -0{\cdot}207$, $P = 0{\cdot}027$), middle education level ($\beta = -0{\cdot}975$, $P < 0{\cdot}001$), high education level ($\beta = -1{\cdot}376$, $P < 0{\cdot}001$), races other than white ($\beta = -0{\cdot}366$, $P < 0{\cdot}001$) and being unemployed ($\beta = -0{\cdot}369$, $P < 0{\cdot}046$). These variables explained 54 % of diet quality (Table 4).

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Table 1 Total score (expressed as mean with 95 % confidence interval) on the Brazilian Healthy Eating Index-Revised (BHEI-R) according to sociodemographic characteristics among 643 adults (aged 20–59 years) and 545 older adults (aged ≥60 years) from the 2015 Health Survey of São Paulo (2015 ISA-Capital) with Focus on Nutrition Study (2015 ISA-Nutrition), Brazil

			BHEI-R†		
Variable	*n**	%	Mean‡	95 % CI	*P*§
Sex (*n* 1188)					<0·001
Male	555	49·77	65·22	65·04, 65·40	
Female	633	50·23	65·71	65·52, 65·89	
Age group (*n* 1188)					<0·001
20–39 years	323	37·25	63·49	63·41, 63·57	
40–59 years	320	33·23	65·56	65·47, 65·64	
≥60 years	545	29·52	67·85	67·77, 67·93	
Race (skin colour; *n* 1180)					<0·001
White	611	51·24	65·77	65·59, 65·95	
Races other than white‖	569	48·76	65·15	64·99, 65·31	
Marital status (*n* 1183)					0·711
Living without partner	531	43·57	65·43	65·20, 65·66	
Living with partner	652	56·43	65·48	65·31, 65·66	
Education¶ (*n* 1185)					<0·001
Low (<7 years)	434	27·70	66·74	66·52, 66·96	
Middle (7–12 years)	491	43·86	65·00	64·80, 65·21	
High (>12 years)	260	28·44	64·92	64·69, 65·15	
Household income per capita** (*n* 1140)					0·003
Low (<$US 236)	330	32·69	65·02	64·80, 65·24	
Middle ($US 236–708)	323	31·45	65·47	65·26, 65·68	
High (>$US 708)	318	35·86	65·68	65·43, 65·93	
Occupation (*n* 1158)					<0·001
Blue collar	426	40·99	64·96	64·82, 65·10	
White collar	203	22·37	64·86	64·60, 65·12	
Other occupation††	466	30·39	67·09	66·86, 67·32	
Unemployed	63	6·25	64·38	64·02, 64·73	
Consumer goods‡‡ (*n* 1162)					0·259
1–5	72	4·99	65·90	65·37, 66·42	
6–10	548	44·88	65·42	65·23, 65·62	
≥11	542	50·13	65·48	65·30, 65·66	

*Excluded individuals with information ignored.
†Analyses considered the sample design (survey mode).
‡Variables adjusted for sex and age.
§Descriptive level of the Wald test or one-way ANOVA: $P < 0·05$.
‖Races other than white: black, greyish-brown, yellow and indigenous.
¶Years of education in tertiles: low, middle and high.
**Monthly household income per capita in tertiles: low, middle and high.
††Including students, housewives, retirees and pensioners.
‡‡Refrigerator, freezer, water filter, microwave, dishwasher, washing machine, television, DVD player, air conditioning, vacuum cleaner, landline, cell phone, camera, motorcycle, bicycle and car.

Discussion

The study population presented differences in BHEI-R score according to SDH (i.e. education, income, sex and race). The components whole grains, sodium and SoFAAS were the ones with scores that were furthest from the ideal for the population. The factors associated with diet quality of residents from São Paulo in 2015 were energy intake, presence of chronic diseases, alcohol consumption, education, income, race and occupation. These findings are in line with evidence showing that diet quality and eating behaviours are influenced by several factors embedded in socio-economic, political and cultural contexts and lifestyle and health behaviours[34–39].

A study evaluating data from 187 countries showed that Brazil was the one that presented the greatest improvement in diet quality in the year 2010 compared with previous years[2]. In residents from São Paulo in the year of 2002, the maximum HEI score achieved was 60·4[40]. The present study shows that the diet quality of the São Paulo population was greater than this value with an average BHEI-R score of 65·5, indicating that the population from São Paulo has increased its diet quality but improvements are still needed.

The BHEI-R components that presented adherence below 50 % in the current study were whole grains (12·6 %), sodium (25·0 %) and SoFAAS (46·4 %). Improvement in these specific components could result in an important increase in overall diet quality. In this sense, the WHO recommends that an adequate diet quality should contain fruit, vegetables and whole grains, and up to 5 % of added sugars, up to 30 % of fat in relation to total energy intake and up to 5 g of salt.

Table 2 Total score (expressed as mean with 95 % confidence interval) on the Brazilian Healthy Eating Index-Revised (BHEI-R) according to lifestyle and health variables among 643 adults (aged 20–59 years) and 545 older adults (aged ≥60 years) from the 2015 Health Survey of São Paulo (2015 ISA-Capital) with Focus on Nutrition Study (2015 ISA-Nutrition), Brazil

			BHEI-R†		
Variable	*n**	%	Mean‡	95 % CI	*P*§
Health insurance (*n* 1183)					0·141
No	737	59·52	65·38	65·21, 65·54	
Yes	446	40·48	65·56	65·36, 65·77	
Chronic non-communicable diseases‖ (*n* 1176)					<0·001
Presence	547	38·12	66·77	66·59, 66·95	
Absence	629	61·88	64·66	64·52, 64·80	
Use of medications (*n* 1185)					<0·001
No	406	38·19	64·59	64·42, 64·76	
Yes	779	61·81	66·00	65·83, 66·16	
Mental health¶ (*n* 1186)					0·612
Positive	230	18·47	65·53	65·25, 65·80	
Negative	956	81·53	65·45	65·29, 65·60	
Smoking (*n* 1185)					<0·001
Never smoke	741	64·40	65·35	65·17, 65·53	
Former smoker	250	18·70	66·03	65·77, 66·28	
Current smoker	194	16·90	65·25	65·05, 65·46	
Alcohol consumption (*n* 1183)					<0·001
Consumer	381	36·37	65·04	64·84, 65·24	
Non consumer	802	63·63	65·70	65·53, 65·88	
Leisure activity physical activity** (*n* 1180)					<0·001
Does not comply with recommendation	942	77·20	65·64	65·48, 65·80	
Complies with recommendation	238	22·80	64·86	64·61, 65·10	
Self-perception of health (*n* 1183)					<0·001
Regular, bad or very bad	383	28·29	65·89	65·66, 66·12	
Excellent, good or very good	800	71·71	64·86	65·14, 65·46	
Weight status†† (*n* 1157)					0·561
Not overweight	613	50·98	65·49	65·28, 65·70	
Overweight/obese	544	49·02	65·42	65·26, 65·57	

*Excluded individuals with information ignored.
†Analyses considered the sample design (survey mode).
‡Variables adjusted for sex and age.
§Descriptive level of the Wald test or one-way ANOVA: $P < 0·05$.
‖Hypertension, type 2 diabetes mellitus, hypercholesterolaemia and cancer.
¶Self-Reporting Questionnaire (SRQ-20): positive or negative, with a cut-off point of 7 for women and 6 for men.
**Whether or not complies with the WHO global recommendation of ≥150 min/week.
††Adults: BMI < 18·5 kg/m^2 and BMI = 18·5–24·99 kg/m^2 (not overweight); BMI = 25·0–29·99 kg/m^2 and BMI ≥ 30·0 kg/m^2 (overweight and obese). Older adults: BMI ≤ 23·0 kg/m^2 and BMI = 23·0–27·99 kg/m^2 (not overweight); BMI = 28·0–29·99 kg/m^2 and BMI ≥ 30·0 kg/m^2 (overweight and obese).

Excessive intake of sodium, added sugars and fat (especially saturated fat) is key in characterizing an unhealthy diet. With regard to saturated fats, the recommendation is to not exceed 10 % of total energy intake and to replace them by unsaturated fats[3].

In a previous study carried out with the first two editions of ISA-Nutrition (2003 and 2008)[41], energy intake, age, smoking and education were associated with diet quality. In the current study (2015 ISA-Nutrition), we observed that, along with education level and energy intake, diet quality was negatively associated with alcohol and race, and positively associated with the presence of chronic diseases and income status; smoking does not appear among the factors. Furthermore, in all ISA-Capital analyses from 2003 to 2015 an inverse association was found between education and diet quality, and this score increases as individuals age[42]. It is important to note that a study showed changes in the patterns of determination of inequalities according to age, ethnic group, education and household income per capita during 2003–2015 in the population of São Paulo, which demonstrates the existence of an ongoing process of demographic and socio-economic factors contributing to diet quality over these years[42]. The social gradient initially identified in diet quality, favouring lower-income individuals in 2003, was diluted over time, gradually favouring individuals with higher income in 2015[42].

Lifestyle habits results indicated that non-smokers and non-alcohol consumers have a better diet quality. Similar to this finding, better scores on diet quality were observed among non-smokers and non-alcohol consumers in studies using the HEI-2005[43,44]. The American Heart Association recommends a moderate consumption of alcohol and to not smoke in order to achieve a healthy diet, combined with a healthy lifestyle[45]. On the other hand, findings from the present study showed that individuals who do not have any chronic non-communicable diseases had lower diet quality compared with those who have at least one such disease. These results refer to a cross-sectional analysis,

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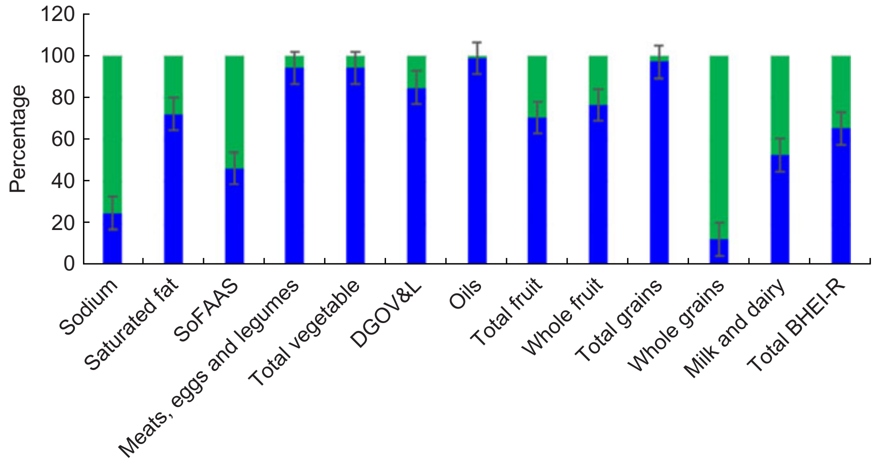

Fig. 1 Component and total scores on the Brazilian Healthy Eating Index-Revised (BHEI-R): the percentage of the maximum score achieved by the population (■; expressed as mean with 95 % confidence interval represented by vertical bar) and the remaining percentage to reach the BHEI-R recommendations (■), among 643 adults (aged 20–59 years) and 545 older adults (aged ≥60 years) from the 2015 Health Survey of São Paulo (2015 ISA-Capital) with Focus on Nutrition Study (2015 ISA-Nutrition), Brazil (SoFAAS, energy from solid fat, alcohol and added sugar; DGOV&L, dark-green and orange vegetables and legumes; oils, vegetable oils, seed oils and fish oils)

hampering cause-and-effect conclusions. Previous history of diabetes mellitus, dyslipidaemia and polypharmacy use in older adults was associated with having better diet quality[46]. However, the presence of at least one chronic non-communicable disease was associated with the use of health services and better orientation and concern about health conditions in previous studies[47,48], which could explain these results.

The BHEI-R total score presented significant differences according to education level. The individuals with the highest education level had a lower diet quality. These conclusions may differ according to the population studied given that, in many developed countries, epidemiological studies observed a positive relationship between education and diet quality[34–36]. Another study that used the HEI-2005 and compared weight, age, sex and educational level of Turkish adults as potential factors for diet quality found that <8 years of education was associated with a diet quality score of 58·3 (SE 13·6) points and the highest education category (>8 years) had a score of 54·7 (SE 14·0) points, coinciding with the present study[49]. In the 2003 ISA-Nutrition[41], saturated fat and SoFAAS components increased in individuals with a higher education level and an inverse association was found between years of study and BHEI-R.

Guenther *et al.*[50] did not find significant differences between mean global HEI-2005 scores for lower- and higher-income American adults and older adults, but important differences were found in total vegetable (3·0 (95 % CI 2·9, 3·2) points and 3·3 (95 % CI 3·2, 3·4) points) and whole grain (0·8 (95 % CI 0·7, 0·9) points and 0·9 (95 % CI 0·9, 1·0) points) components, with differences by family income status. In the present study, individuals with higher income presented higher scores for total BHEI-R as well as total and whole fruit, total vegetable and SoFAAS components, and lower score for the sodium component. These differences can be explained because of the different profiles of the populations studied, income levels, age group categorizations and the year the survey was taken (in Brazil it took place in 2015, in the USA in 2003–2004)[50]. However, Portero-McLellan *et al.* found similar findings to those of the present study when evaluating the diet quality of adults and older adults living in the countryside of São Paulo. The diet quality was evaluated according to income group using the HEI and a better diet quality was observed in individuals who attained to a higher income status, with increased intakes of protein, dairy products, fruits and vegetables[51]. On the other hand, low-income families showed increased consumption of industrialized foods, such as sweets and sugar-sweetened beverages (soft drinks and fruit juices), and reduced consumption of fruits and vegetables[52].

Occupation was the only SDH variable evaluated in which there was no difference in overall diet quality, although white-collar workers presented higher scores for the whole grains, milk and dairy, and sodium components; and blue-collar workers presented higher scores for total vegetables, DGOV&L, total grains, meats, eggs and legumes, oils and saturated fat components. Another study with Norwegians aged 16–79 years showed that white-collar workers from both sexes presented higher consumption of fruit, vegetables and fibre while the blue-collars workers had increased intakes of SFA and cholesterol[37]. However, the 'other occupation' category presented a better diet quality compared with blue-collar workers, because retirees, pensioners, students and housewives were included in this, corroborating the results of the present study[18].

Socio-economic status includes occupation, income and years of education because they are intercorrelated; however, many studies evaluate socio-economic status using

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Table 3 Component and total scores (expressed as means with their standard errors) on the Brazilian Healthy Eating Index-Revised (BHEI-R) according to structural social determinants of health among 643 adults (aged 20–59 years) and 545 older adults (aged ≥60 years) from the 2015 Health Survey of São Paulo (2015 ISA-Capital) with Focus on Nutrition Study (2015 ISA-Nutrition), Brazil

	Education†								Income‡								Occupation§								Sex					Race				
	Low		Middle			High			Low		Middle			High			Blue collar		White collar			Other			Male		Female			White		Races other than white		
BHEI-R component (maximum score)*	Mean	SE	Mean	SE	*P*‖	Mean	SE	*P*‖,¶	Mean	SE	Mean	SE	*P*‖	Mean	SE	*P*‖,¶	Mean	SE	Mean	SE	*P*‖	Mean	SE	*P*‖,¶	Mean	SE	Mean	SE	*P*‖	Mean	SE	Mean	SE	*P*‖
Total fruit (5)	4·07	0·02	3·76	0·02	<0·001	3·74	0·02	<0·001	3·76	0·02	3·85	0·02	0·002	3·88	0·02	<0·001	3·76	0·01	3·73	0·02	0·251	4·12	0·02	<0·001	3·83	0·02	3·86	0·02	0·179	3·89	0·02	3·79	0·01	<0·001
Whole fruit (5)	3·73	0·02	3·44	0·02	<0·001	3·45	0·02	<0·001	3·46	0·02	3·52	0·02	0·024	3·56	0·03	0·002	3·41	0·01	3·44	0·02	0·326	3·82	0·02	<0·001	3·40	0·01	3·65	0·01	<0·001	3·59	0·02	3·46	0·01	<0·001
Total vegetable (5)	4·75	0·00	4·71	0·00	<0·001	4·70	0·00	<0·001	4·71	0·00	4·72	0·00	0·001	4·73	0·00	<0·001	4·71	0·00	4·70	0·00	0·005	4·76	0·00	<0·001	4·73	0·00	4·71	0·00	<0·001	4·73	0·00	4·71	0·00	<0·001
DGOV&L (5)	4·29	0·01	4·24	0·01	<0·001	4·21	0·01	<0·001	4·23	0·01	4·26	0·01	0·002	4·25	0·01	0·077	4·28	0·01	4·21	0·01	<0·001	4·25	0·01	0·008	4·39	0·00	4·11	0·00	<0·001	4·24	0·01	4·26	0·01	0·066
Total grains (5)	4·86	0·00	4·86	0·00	<0·001	4·86	0·00	0·399	4·86	0·00	4·86	0·00	0·327	4·86	0·00	0·709	4·87	0·00	4·86	0·00	<0·001	4·85	0·00	<0·001	4·89	0·00	4·84	0·00	<0·001	4·86	0·00	4·87	0·00	<0·001
Whole grains (5)	0·66	0·01	0·61	0·00	<0·001	0·62	0·01	<0·001	0·62	0·01	0·62	0·00	0·534	0·63	0·01	0·103	0·59	0·00	0·62	0·01	<0·001	0·69	0·00	<0·001	0·56	0·00	0·70	0·00	<0·001	0·64	0·00	0·61	0·00	<0·001
Milk and dairy (10)	5·47	0·03	5·18	0·03	<0·001	5·26	0·04	<0·001	5·24	0·03	5·25	0·03	0·875	5·32	0·05	0·206	5·07	0·03	5·27	0·04	<0·001	5·68	0·02	<0·001	4·80	0·01	5·76	0·02	<0·001	5·39	0·03	5·18	0·02	<0·001
Meats, eggs and legumes (10)	9·42	0·01	9·45	0·01	0·037	9·41	0·02	0·686	9·43	0·01	9·45	0·01	0·144	9·43	0·02	0·981	9·51	0·01	9·41	0·02	<0·001	9·34	0·01	<0·001	9·65	0·00	9·22	0·00	<0·001	9·40	0·01	9·47	0·01	<0·001
Oils (10)	9·88	0·00	9·90	0·00	<0·001	9·90	0·00	<0·001	9·90	0·00	9·90	0·00	0·129	9·89	0·00	0·017	9·91	0·00	9·90	0·00	0·017	9·86	0·00	<0·001	9·92	0·00	9·87	0·00	<0·001	9·89	0·00	9·90	0·00	<0·001
Saturated fat (10)	7·32	0·01	7·23	0·01	<0·001	7·18	0·02	<0·001	7·21	0·02	7·26	0·01	0·002	7·25	0·02	0·062	7·29	0·01	7·17	0·02	<0·001	7·25	0·01	0·026	7·47	0·01	7·02	0·01	<0·001	7·23	0·01	7·26	0·01	0·087
Sodium (10)	2·32	0·02	2·54	0·02	<0·001	2·61	0·02	<0·001	2·57	0·02	2·47	0·02	<0·001	2·47	0·02	0·002	2·48	0·02	2·63	0·03	<0·001	2·38	0·02	<0·001	2·24	0·01	2·76	0·01	<0·001	2·50	0·02	2·50	0·02	0·827
SoFAAS (20)	9·97	0·06	9·05	0·05	<0·001	8·97	0·06	<0·001	9·04	0·06	9·30	0·06	0·001	9·40	0·06	<0·001	9·08	0·04	8·93	0·07	0·076	10·09	0·06	<0·001	9·35	0·05	9·22	0·05	0·047	9·42	0·05	9·14	0·04	<0·001
BHEI-R (100)	66·74	0·11	65·00	0·10	<0·001	64·92	0·12	<0·001	65·02	0·11	65·47	0·11	0·004	65·68	0·13	<0·001	64·96	0·07	64·86	0·13	0·525	67·09	0·12	<0·001	65·22	0·09	65·71	0·09	<0·001	65·77	0·09	65·15	0·08	<0·001

DGOV&L, dark-green and orange vegetables and legumes; oils, vegetable oils, seed oils and fish oils; SoFAAS, energy from solid fat, alcohol and added sugar.
*Analyses considered the sample weight and were adjusted by sex and age.
†Education (low, <7 years; middle, 7–12 years; high, >12 years).
‡Monthly household income per capita (low, <$US 236; middle, $US 236–708; high, >$US 708).
§Excluded the category unemployed.
‖Descriptive level of the Wald test: $P < 0·05$.
¶Wald test between low and high categories, or between blue collar and others.

Table 4 Multiple regression analysis of factors associated with the Brazilian Healthy Eating Index-Revised (BHEI-R) among 643 adults (aged 20–59 years) and 545 older adults (aged ≥60 years) from the 2015 Health Survey of São Paulo (2015 ISA-Capital) with Focus on Nutrition Study (2015 ISA-Nutrition), Brazil

Independent variable*	β†	P‡	R^2§
Energy (kcal)	−0·001	<0·001	0·540
Presence of diseases	0·636	<0·001	
Alcohol consumption (ref. No)			
Yes	−0·207	0·027	
Education (ref. Low education)			
Middle education	−0·975	<0·001	
High education	−1·376	<0·001	
Income status (ref. Low income)			
Middle income	0·478	<0·001	
High income	0·966	<0·001	
Occupation (ref. Blue collar)			
White collar	−0·020	0·866	
Other	1·418	<0·001	
Unemployed	−0·369	0·046	
Race (ref. White)			
Races other than white	−0·366	<0·001	

Ref., reference category.
*Analyses considered the sample design.
†Linear regression coefficient.
‡Descriptive level: $P < 0.05$.
§Explained variance.

only one of its variables[36,53]. In the present study, these variables were analysed individually in order to evaluate single results and observe how they are associated to diet quality. Thus, the results indicate that individuals of middle and high income present better global diet quality, but an inverse relationship is observed with education, and there is no association with blue- and white-collar workers. Evidence shows that food cost is one of the key determinants when low-income individuals chose their food, demonstrating the existence of a social gradient in diet quality. Since price may not be a limitation, individuals with high socio-economic status eat more healthfully[54,55]. Evidence from low- and middle-income countries, specifically Brazil, showed that an unhealthy diet pattern is more common in individuals from low socio-economic levels[56]. This has been associated with a high prevalence of overweight and obesity[56]. On the other hand, individuals from high socio-economic levels have a higher chance of following a better quality of diet, which is associated with higher intake of fruits and vegetables[56].

Differences between sexes were identified in a population-based study conducted in 2008 in the countryside of São Paulo, Brazil, where women had lower scores for meats and eggs (8·09 *v.* 8·47 points), sodium (0·94 *v.* 0·37 points) and saturated fat (7·87 *v.* 8·41 points), and higher scores for total fruit (2·00 *v.* 1·51 points) and milk and dairy (3·76 *v.* 2·96 points), compared with men[11], which is in agreement with the present study. A study conducted in Australia with adults and older adults found significant differences in diet quality between sexes, with women presenting a lower score for the sodium component and higher scores for vegetables, fruit, milk and dairy, lean meat and total fat[57], similarly to the present study, where women presented higher scores for total fruit, whole grains, milk and dairy, and sodium. These findings can be explained by the fact that women usually are more concerned with their body and are more aware of nutritional information, leading to healthier food choices compared with men[57]. A higher education level and, as a consequence, increased knowledge was one of the factors that led women to adhere to a healthier diet[58].

The Multi-Ethnic Study of Atherosclerosis (MESA) identified ethnic differences in relation to HEI-2005 components, where individuals of White ethnicity scored higher in the fruit group compared with Chinese, and scored higher in milk and dairy compared with Chinese and African-Americans, as well as scoring lower in saturated fat in relation to Chinese and African-Americans[59]. In the present study, whites obtained higher scores for total and whole fruit, total vegetables, whole grains, milk and dairy, and SoFAAS; and races other than white had higher scores for total grains, meats, eggs and legumes, and oils. A study with American adults reported that the factors that affect food choice, such as convenience, safety, nutrition and price, have a stronger impact among African-Americans compared with White individuals, which may explain this finding[60].

It is important to highlight some Brazilian public health approaches that may help shape how to address social inequities that impact diet. The National Food and Nutrition Policy (Política Nacional de Alimentação e Nutrição (PNAN))[61] is focused on reducing inequalities in social determinants and the Support Centers for Family Health (Núcleos de Apoio à Saúde da Família (NASF)) in the Brazilian Unified Health System (Sistema Único de Saúde (SUS)) were created to broaden basic health care and promote more nutrition-related actions in the health services. There is also a movement to incentivize the purchase of foods from family farming by the Brazilian National School Feeding Program (Programa Nacional de Alimentação Escolar (PNAE))[62]. The 2014 Dietary Guidelines for the Brazilian Population have the objective of expanding knowledge on the determinants of healthy eating, allowing the population to make better choices[63].

The present study has limitations. During application of the 24HR, respondents may have had difficulties in reporting details of their diets, such as the types of fats and oils used, as well as the amounts used in food preparation, but this limitation is present equally among all individuals[29]. Literature study comparisons were hampered by differences in dietary patterns, the use of different diet quality indices (i.e. BHEI-R *v.* HEI in different countries) and the lack of tools to enable them to be performed, because studies that use indices to assess diet quality present different cut-off points when assessing diet quality[64] due to cross-cultural adaptations. However, these tools presented adequate validity and reproducibility.

The strength of the present study is the use of two 24HR that allowed the estimation of individual habitual food consumption by removing intrapersonal diet variability[30]. The study includes a representative population-based survey from the largest Brazilian city, which guarantees internal validity and minimizes selection bias. The study was designed to provide an updated overview of diet quality and its relationship with social determinants and lifestyle using a representative sample of residents of the city of São Paulo.

Conclusions

Groups affected by socio-economic inequalities (i.e. education level, income status, occupation, sex and race) should be the target of campaigns to provide an adequate diet quality. An improvement in the consumption of specific components (i.e. whole grains, sodium and energy from SoFAAS) should be achieved in order to reach optimal index values. Therefore, governmental actions in public health should be carried out in order to reduce the consumption of energy-dense (i.e. high in solid fats and added sugars) and sodium-rich foods, as well as facilitating access and information on healthy eating and conducting nutritional education campaigns and activities. Policy makers, researchers and practitioners should work together in order to encourage the key points of a healthy lifestyle: healthy eating, reducing the intake of alcoholic beverages, not smoking and increasing the levels of physical activity.

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