Universidade de São Paulo
Faculdade de Saúde Pública

**Dieta, excesso de peso e fatores de risco
cardiometabólico na população da cidade de São
Paulo: panorama 2003 – 2015**

Jaqueline Lopes Pereira França

Tese apresentada ao Programa de Pós-
Graduação em Nutrição em Saúde Pública
para obtenção do título de Doutor em Ciências.

Área de Concentração: Nutrição em Saúde
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Orientadora: Prof^a. Assoc. Regina Mara
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*Ao coração que bate em
meu ventre.*

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RESUMO

Pereira JL. Dieta, excesso de peso e fatores de risco cardiometabólico na população da cidade de São Paulo: panorama 2003 – 2015 [tese do Programa de Nutrição em Saúde Pública]. São Paulo: Faculdade de Saúde Pública da Universidade de São Paulo; 2018.

Introdução: O excesso de peso (EP, inclui sobrepeso e obesidade) configura um grande problema de saúde pública no país. A compreensão do estado nutricional ao longo do tempo e de fatores associados, como a dieta, além de suas possíveis consequências, como fatores de risco cardiometabólico, é essencial para o desenvolvimento de ações em saúde. **Objetivo:** Avaliar a prevalência de sobrepeso e obesidade na população da cidade de São Paulo, assim como modificações na dieta da população entre os anos de 2003 e 2015 e sua associação com fatores de risco cardiometabólico. **Métodos:** Foram utilizados dados do estudo transversal de base populacional ISA - Capital dos anos de 2003, 2008 e 2015, referentes à amostra probabilística de residentes do município de São Paulo com 12 anos ou mais, de ambos os sexos, totalizando 8.682 indivíduos. Dados socioeconômicos, antropométricos, de estilo de vida e recordatório alimentar de 24 horas foram coletadas em visitas domiciliares e inquérito telefônico. Os indivíduos foram classificados segundo IMC em duas categorias: com e sem EP. Os fatores de risco cardiometabólico avaliados foram: circunferência de cintura aumentada, pressão arterial sistólica ou diastólica elevada, dislipidemia, glicemia de jejum ou hemoglobina glicada elevadas e resistência à insulina. Foram avaliados a frequência de consumo e o tamanho das porções de 30 grupos de alimentos e a qualidade da dieta, utilizando o Índice de Qualidade da Dieta Revisado para a população brasileira (IQD-R) e o Alternate Healthy Eating Index-2010 (AHEI) americano. Variáveis categóricas foram descritas e comparadas por teste qui-quadrado de Pearson e intervalo de confiança de 95%. Foram utilizados modelos de regressão logística e logística ordinal para avaliar a associação das variáveis investigadas com EP e com fatores de risco cardiometabólico. **Resultados:** No período avaliado, a prevalência de obesidade na população dobrou: de 10% (8,0; 12,5) em 2003 para 19,2% (17,8; 20,6) em 2015, sendo o maior aumento entre adolescentes e adultos do sexo feminino.

Adultos, pessoas com maior renda e ex-fumantes apresentaram maior chance de ter EP, o qual aumentou 31% entre 2003 e 2008 e 126% entre 2003 e 2015, quando metade da população passou a ter EP. Se esse padrão se mantiver, espera-se que 77% da população tenha EP em 2030. Neste período, houve uma variação no tamanho das porções consumidas, com aumento em alguns grupos de alimentos (carne branca, salgados, café/chá, ovos) e redução em outros (arroz, carne vermelha, doces, massas, sanduíches, frios). Além disso, a frequência de consumo de seis grupos aumentou no período (arroz, carne branca, doces, frutas, sucos industrializados, torradas/biscoitos). Nesta população, o EP se associou positivamente com maiores porções de frios, petiscos fritos, sucos naturais e industrializados, pizza, carne vermelha, arroz, salgados, refrigerantes, sopas e açúcar. Em relação à qualidade da dieta, adolescentes com EP apresentaram pior qualidade da dieta para os componentes grãos integrais (IQD-R) e bebidas açucaradas (AHEI) em relação aos adolescentes sem EP. O IQD-R foi inversamente associado ao EP (OR=0.87; 0.80, 0.95) e ao número de fatores de risco cardiovascular (OR=0.89; 0.80, 0.98) nesta população. **Conclusões:** O EP aumentou substancialmente em um curto período na cidade de São Paulo, especificamente em alguns subgrupos e se associou positivamente com maior tamanho da porção de 11 grupos de alimentos na população geral e com menor qualidade da dieta entre os adolescentes. Adolescentes com menor qualidade da dieta também apresentaram maior chance de ter mais fatores de risco cardiometabólico. Esses achados podem subsidiar intervenções e políticas para redução da tendência de aumento do excesso de peso e melhora no consumo alimentar na população.

Descritores: sobrepeso, obesidade, tamanho da porção, qualidade da dieta, consumo alimentar, epidemiologia nutricional, São Paulo.

ABSTRACT

Pereira JL. Diet, excess body weight and cardiometabolic risk factors in the population of São Paulo city: panorama 2003 – 2015. São Paulo: School of Public Health of the University of São Paulo; 2018.

Introduction: Excess body weight (EBW, including overweight and obesity) is a major public health problem in the country. Understanding nutritional status over time and associated factors, such as diet, besides its consequences, such as cardiometabolic risk factors, is essential for the development of interventions in health. **Objective:** To evaluate the prevalence of overweight and obesity in the population of the city of São Paulo, as well as changes in diet between 2003 and 2015, and its association with cardiometabolic risk factors. **Methods:** We used data from the cross-sectional population based study ISA-Capital 2003, 2008, and 2015, with probabilistic sampling of residents of the city of São Paulo aged 12 years and more, of both sexes, totaling 8,682 individuals. Socioeconomic, anthropometric, and lifestyle data and 24-hour dietary recalls were collected in the households and by telephone. The individuals were categorized according to BMI in two categories: with and without EBW. The evaluated cardiometabolic risk factors were: central obesity, hypertension, dyslipidemia, high fasting glycaemia or glycated hemoglobin, and insulin resistance. We evaluated the frequency of intake and the portion sizes of 30 food groups, besides the diet quality, using the Revised Diet Quality Index for Brazilian population (BHEI-R) and the American Healthy Eating Index-2010 (AHEI). Categorical variables were described and compared by Pearson's chi-square test and 95% confidence interval. Ordinal logistic and logistic regression models were performed to evaluate the association of the investigated variables with EBW and cardiometabolic risk factors. **Results:** The prevalence of obesity in the population doubled in the evaluated period, from 10% (8.0; 12.5) in 2003 to 19.2% (17.8; 20.6) in 2015, with the highest increase among female adolescents and adults. Adults, those with higher income, and former smokers were more likely to have EBW, which increased 31% between 2003 and 2008, and 126% between 2003 and 2015, when half of the population had EBW. If this pattern continues, it is expected that 77% of the population will have EBW by 2030. During this period, there was a

variation in the portion sizes of food groups consumed, with increase in some groups (white meat, salted snacks, coffee/tea, eggs) and decrease in others (rice, red meat, sweets, pasta, sandwiches, cold cuts). In addition, there was an increase in the frequency of consumption of six groups (rice, white meat, sweets, fruits, commercial juices, toasts/biscuits). In this population, EBW was positively associated with larger portions of cold cuts, fried snacks, fruit and commercial juices, pizza, red meat, rice, salted snacks, soft drinks, soups and sugar. Regarding diet quality, adolescents with EBW had lower diet quality for the components whole grains (BHEI-R) and sugar sweetened beverages (AHEI) compared with adolescents without EBW. BHEI-R was inversely associated with EBW (OR = 0.87, 0.80, 0.95) and cardiovascular risk factors count (OR = 0.89, 0.80, 0.98) in this population. **Conclusions:** EBW increased substantially over a short period in the city of São Paulo, especially in some subgroups and it was positively associated with larger portion size of 11 food groups in the population, and with lower diet quality among adolescents. Also, adolescents with lower diet quality were more likely to have higher number of cardiovascular risk factors. These findings can subsidize interventions and policies to reduce the tendency of increase in EBW and to improve food intake in the population.

Keywords: overweight, obesity, portion size, diet quality, dietary intake, nutritional epidemiology, São Paulo.

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SIGLAS UTILIZADAS

AHEI: Alternate Health Eating Index

AIC: Akaike's Information Criterion

AMD: Alternate Mediterranean Diet

ATP III: Adult Treatment Panel III

AUDIT: Alcohol Use Disorders Identification Test

BIC: Basic Information Criterion

BMI: Body Mass Index

CA: Central Adiposity

CAGE: Cut Down, Annoyed by Criticism, Guilty and Eyeopener

CDC: Centers for Disease Control and Prevention

CI: Confidence Interval

CL: Confidence Limit

CNPq: Conselho Nacional de Desenvolvimento Científico e Tecnológico

CT: Colesterol Total

CVDR: Cardiovascular disease risk factors

DALYs: Disability-Adjusted Life Years

DASH: Dietary Approaches to Stop Hypertension

DCNT: Doenças crônicas não transmissíveis

DP: Desvio Padrão

EBW: Excess Body Weight (overweight and obesity)

EDTA: Ácido etileno-diamino-tetracético

ER: Energia Relatada (Energy Intake - EI)

ERICA: Estudo dos Riscos Cardiovasculares em Adolescentes

EUA: Estados Unidos da América (USA)

FAO: Food and Agriculture Organization of the United Nations

FAPESP: Fundação de Amparo à Pesquisa do Estado de São Paulo

FLV: Frutas, legumes e verduras

g: Gramas

gord_AA: Energia proveniente de gordura sólida, açúcar de adição e álcool (SoFAS)

HCHS/SOL: Hispanic Community Health Study/Study of Latinos

HDL-C: Lipoproteína De Alta Densidade

HEI: Health Eating Index

HOMA-IR: Homeostatic Assessment of Insulin Resistance

HPFS: Health Professionals Follow-Up Study

IBGE: Instituto Brasileiro de Geografia e Estatística

IC 95%: Intervalo de Confiança de 95%

IDF: International Diabetes Federation

IMC: Índice de Massa Corporal

INA: Inquérito Nacional de Alimentação

IOM: Institute of Medicine of the National Academies

IPAQ: Questionário de Atividade Física Internacional

IQD-R: Índice de qualidade da dieta revisado para a população brasileira (BHEI-R)

IQR: Interquartile Range

ISA-Capital: Inquérito de Saúde de São Paulo, Health Survey of São Paulo (HSP)

ISA-Nutrição: Inquérito de Saúde de São Paulo com foco em Nutrição (ISA-Nutrition)

kcal: Quilocalorias

kg: Quilogramas

LDL-C: Lipoproteína de Baixa Densidade

MPM: Multiple Pass Method

MSM: Multiple Source Method

NCEP: National Cholesterol Education Programme

NCI: National Cancer Institute

NDSR: Nutrition Data System for Research

NEE: Necessidade energética estimada (EER)

NHANES: National Health and Nutrition Examination Survey

NHS: Nurses' Health Study

OMS: Organização Mundial de Saúde (World Health Organization - WHO)

OPAS: Organização Pan Americana de Saúde

OR: Odds Ratio

PIB: Produto Interno Bruto

POF: Pesquisa de Orçamentos Familiares

R24h: Recordatório alimentar de 24 horas

SABE: Estudo Saúde, bem-estar e envelhecimento

SD: Standard Deviation

SE: Standard Error

SISVAN: Sistema de Vigilância Alimentar e Nutricional

SOL-Youth: Hispanic Community Children's Health Study/Study of Latino Youth

SSB: Sugar Sweetened Beverages

SUS: Sistema Único de Saúde

TG: Triglicérides

UPA: Unidades Primárias de Amostragem

USDA: United States Department of Agriculture

VET: Valor Energético Total

VeVEAl: Vegetais verde-escuros e alaranjados e leguminosas (DGOV&L)

VIGITEL: Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico

WOF: World Obesity Federation

APRESENTAÇÃO

Este trabalho utilizou dados das pesquisas “Inquérito de Saúde do Município de São Paulo” (ISA-Capital), com amostra representativa da população de adolescentes, adultos e idosos da cidade de São Paulo, e “Hispanic Community Children’s Health Study/Study of Latino Youth” (SOL-Youth), com adolescentes latinos/hispânicos que vivem em quatro cidades dos EUA. Foi orientado por Regina Mara Fisberg, membro da equipe de pesquisadores do ISA-Capital, e por Josiemer Mattei (durante o período de doutorado sanduíche), membro da equipe de pesquisadores do SOL-Youth.

A estrutura desta tese foi elaborada de acordo com as diretrizes aprovadas na 9ª sessão de 05/6/2008 da Comissão de Pós-Graduação da Faculdade de Saúde Pública da Universidade de São Paulo e com as recomendações do Guia de Apresentação de Teses desta instituição (CUENCA et al., 2006). Inclui as seções: (1) Introdução, com o referencial teórico sobre excesso de peso, tamanho da porção, qualidade da dieta e risco cardiometabólico; (2) Justificativa do trabalho; (3) Objetivos, descrevendo os propósitos gerais e específicos do estudo; (4) Métodos, com o delineamento dos estudos utilizados, definições, procedimentos e análises realizadas; (5) Resultados e Discussão, que apresenta três manuscritos resultantes do projeto de pesquisa de doutorado: o primeiro, intitulado “*Excess body weight in the city of São Paulo: panorama from 2003 to 2015, associated factors and projection for the next years*” e o segundo, “*Differences over 12 Years in Food Portion Size and Association with Excess Body Weight in the City of São Paulo, Brazil*”, avaliam a população de adolescentes, adultos e idosos da cidade de São Paulo; o terceiro, “*Diet*

quality, excess body weight, and cardiometabolic risk factors in adolescents living in São Paulo, Brazil and in the USA – differences and similarities”, avalia dados da população de adolescentes da cidade de São Paulo e dos adolescentes latinos vivendo nos EUA; (6) Considerações Finais, com resumo das principais contribuições do estudo.

1 INTRODUÇÃO

1.1 EPIDEMIOLOGIA DO EXCESSO DE PESO

O excesso de peso se tornou um problema de saúde pública mundial nas últimas quatro décadas e um desafio para os sistemas de saúde de diversos países (WHO, 2000). Estima-se que no ano de 2030, 38% da população mundial terá sobrepeso e 20% será obesa (KELLY et al., 2005). Diversas pesquisas têm sido feitas ao redor do mundo, na tentativa de compreender, prevenir e modificar esse cenário, porém, a tendência ainda é de crescimento em diversas populações (HRUBY e HU, 2015).

1.1.1 Classificação

O excesso de peso é caracterizado pelo acúmulo de tecido adiposo corporal e pode ser classificado em sobrepeso e obesidade em diferentes graus, conforme os riscos para a saúde dos indivíduos (WHO, 2000). A medida mais comumente utilizada para sua classificação em estudos epidemiológicos é o índice de massa corporal (IMC), obtido pela razão do peso (kg) pelo quadrado da altura (m^2) (QUETELET, 1869).

Apesar de não refletir as variações na distribuição e percentual de gordura corporal, a facilidade de obtenção de dados de peso e estatura, bem como sua boa correlação com morbidade e mortalidade justificam a utilização do IMC em estudos epidemiológicos, desde que pontos de corte específicos para cada idade sejam

utilizados (WHO, 2000). Existem diversos pontos de corte para classificação dos indivíduos, sendo que os mais comumente utilizados estão descritos no Quadro 1, segundo faixa etária.

Entre os adultos (20 a 59 anos), a classificação baseada no IMC proposta pela Organização Mundial de Saúde (OMS) é um consenso, variando de baixo peso ($< 18,5 \text{ kg/m}^2$) a obesidade severa ($\geq 40 \text{ kg/m}^2$) (WHO, 2000). A OMS indica a utilização desses pontos de corte para todos os indivíduos com 20 anos ou mais, porém, diferenças na composição corporal que ocorrem fisiologicamente no envelhecimento, como redução da estatura, da massa corporal magra e da quantidade de água no organismo, além do acúmulo de tecido adiposo (BEDGONI et al., 2001), fizeram com que outros pontos de corte que considerassem essas diferenças fossem propostos para esta população. O ponto de corte que determina excesso de peso para idosos brasileiros, segundo recomendações do Sistema de Vigilância Alimentar e Nutricional, e com base na publicação do *The Nutrition Screening Initiative* (1994), é de $\text{IMC} > 27 \text{ kg/m}^2$, sem diferenciar sobrepeso de obesidade (SISVAN, 2011). Já os pontos de corte propostos pela Organização Pan Americana de Saúde (OPAS), com base no estudo Saúde, bem-estar e envelhecimento (SABE), com idosos de países latino-americanos, inclusive o Brasil, diferencia sobrepeso como $28 < \text{IMC} < 30 \text{ kg/m}^2$ e obesidade para aqueles com $\text{IMC} \geq 30 \text{ kg/m}^2$ (LEBRÃO et al., 2003).

Para adolescentes, a variação nos pontos de corte segundo idade ocorre devido à modificação na composição corporal que ocorre durante seu crescimento, com diferenças entre meninos e meninas, e de acordo com o desenvolvimento e maturação sexual. A classificação da OMS para adolescentes é a mais utilizada atualmente. Ela inclui a população entre 5 e 19 anos (crianças e adolescentes), e é

baseada em dados de crianças de seis regiões do mundo que nasceram e cresceram em condições ótimas (WHO, 2007). Outro ponto de corte utilizado internacionalmente foi proposto pela *World Obesity Federation* (WOF), cuja população de referência foi obtida pela média de uma mistura heterogênea de pesquisas de diferentes países, incluindo EUA e Brasil (COLE et al., 2000). Nesta proposta, os pontos são específicos para cada sexo e idade, baseados em uma curva que atinge os pontos de corte para adultos de um IMC de 25 e 30 kg/m² para sobrepeso e obesidade, respectivamente, aos 18 anos de idade. Para a população dos EUA, o *Centers for Disease Control and Prevention* (CDC) preconiza a utilização de seus pontos de corte, baseados exclusivamente em sua população (KUCZMARSKI et al., 2000).

Quadro 1 – Classificações frequentemente utilizadas para definição de sobrepeso e obesidade em adolescentes, adultos e idosos.

Referência	Idade	Indicador	Eutrofia	Sobrepeso	Obesidade
Adolescentes					
WHO, 2007	5–19 anos	Curva Z IMC para idade	> -2 a ≤ 1 DP	>1 a ≤ 2 DP	> 2 DP
WOF, 2000	2-18 anos	Curva IMC para idade	-	≥ 25 a < 30 kg/m ² aos 18 anos	≥ 30 kg/m ² aos 18 anos
CDC, 2000	2-19 anos	Percentil IMC	$\geq p5$ a $< p85$	$\geq p85$ a $<$ p95	$\geq p95$
Adultos					
WHO, 2000	≥ 20 anos	IMC	18,5 a 24,9	≥ 25 a < 30	≥ 30 Classe 1: 30 a 34,9 Classe 2: 35 a 39,9 Classe 3: ≥ 40
Idosos					
SISVAN, 2011	≥ 60 anos	IMC	22 a 27	≥ 27	
OPAS/SABE, 2003	≥ 60 anos	IMC	23 a 28	≥ 28 a < 30	≥ 30

Abreviações: IMC, índice de massa corporal (kg/m²); DP, desvio padrão.

Adaptado de: HRUBY e HU, 2015; CORTEZ e MARTINS, 2012.

Outra medida frequentemente utilizada para identificar e discriminar o excesso de peso é a circunferência da cintura, que mede adiposidade abdominal (HU, 2007). Para a população adulta brasileira, os valores de circunferência de cintura > 94 cm em homens e > 80 cm em mulheres são considerados indicadores de maior risco de morbimortalidade (WHO, 2000; SISVAN, 2011). Entre adolescentes, não existe uma referência padrão, sendo que alguns estudos utilizam como parâmetro para definição de circunferência de cintura aumentada medidas maiores ou iguais ao percentil 90 para o sexo e idade da tabela do *National Health and Nutrition*

Examination Survey (NHANES), com a população dos EUA (FERNANDEZ et al., 2004).

1.1.2 Prevalência

Estima-se que, em 2016, 340 milhões de crianças e adolescentes de 5 a 19 anos e mais de 1,9 bilhão de adultos (39%) tinham excesso de peso, sendo que mais de 650 milhões (13%) dos adultos eram obesos (WHO, 2018). Uma análise com 1.698 estudos populacionais, com 19,2 milhões de participantes de 200 países mostrou que entre 1975 e 2014, a prevalência de obesidade no mundo praticamente triplicou entre os adultos, aumentando de 3% para 11% em homens e de 6% para 15% em mulheres (NCD-RisC, 2016). Se esta tendência se mantiver, estima-se que praticamente metade da população mundial terá excesso de peso em 2030 (KELLY et al., 2005; DOBBS et al., 2014).

Apesar de vários países desenvolvidos, como EUA, Canadá, e alguns países da Europa, terem observado redução no aumento da obesidade em determinados grupos de suas populações na última década, muitos deles ainda têm prevalências extremamente elevadas, enquanto os países em desenvolvimento, onde quase duas em cada três pessoas obesas no mundo vivem, apresentam tendência contínua de aumento na prevalência de obesidade (NG, 2014). Em todos os países são observadas diferenças nas prevalências e nas tendências segundo diferentes grupos da população, de acordo, por exemplo, com a faixa etária, etnia e extrato socioeconômico (NG, 2014; WHO, 2000).

No Brasil, dados da Pesquisa de Orçamentos Familiares (POF) 2008-2009 mostram que, entre 1975 e 2009, o sobrepeso entre adultos aumentou de 19% para 50% nos homens e de 29% para 48% nas mulheres, enquanto a prevalência de obesidade aumentou de 3% para 12% nos homens e de 8% para 17% nas mulheres (IBGE, 2010). Em 2013, uma análise sistemática com dados de 188 países apontou que, no Brasil, 53% dos homens com mais de 20 anos tinham excesso de peso, sendo que 12% deles eram obesos e, entre mulheres, 58% apresentaram excesso de peso, sendo que 21% apresentaram obesidade (NG, 2014).

Dados da Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico, VIGITEL, com a população das 26 capitais brasileiras e do Distrito Federal, indicam que, em 2016, a prevalência de excesso de peso foi de 54%, sendo maior entre homens (57,7%) do que entre mulheres (50,5%) e a frequência de adultos obesos foi de 19%, ligeiramente maior em mulheres (19,6%) do que em homens (18,1%) (VIGITEL, 2017).

O excesso de peso apresenta prevalência elevada e/ou em crescimento inclusive nas faixas etárias mais jovens (NG et al., 2014). No mundo, a prevalência de excesso de peso entre crianças e adolescentes de 5 a 19 anos aumentou drasticamente, passando de 4% em 1975 para mais de 18% em 2016, de forma similar entre meninos e meninas (WHO, 2018). Enquanto apenas 1% dessa população era obesa em 1975, mais de 124 milhões de crianças e adolescentes (6% das meninas e 8% dos meninos) eram obesos em 2016 (WHO, 2018).

Na América Latina, os jovens são desproporcionalmente afetados pela epidemia de obesidade (WHO, 2016; NG et al., 2014). Em 2013, a maior prevalência de excesso de peso na população entre dois e 20 anos foi observada no Chile (37%),

Uruguai (31%) e México (28%) em meninos, e na Costa Rica (38%), Uruguai (38%) e Chile (32%) em meninas. No Brasil, a prevalência de excesso de peso nessa faixa etária em 2013 era de 22% entre meninos e 24% entre meninas (NG et al., 2014).

Entre 1975 e 2009, a prevalência de excesso de peso nos adolescentes, que correspondem a 18% da população brasileira (IBGE, 2010b), aumentou em seis vezes no sexo masculino (de 4% para 22%) e em quase três vezes no sexo feminino (de 8% para 19%) e a obesidade passou de 0,4% para 6% no sexo masculino e de 0,7% para 4% no sexo feminino (IBGE, 2010). Dados do Estudo dos Riscos Cardiovasculares em Adolescentes (ERICA) apresentam prevalência de 17% de sobrepeso e 8% de obesidade em estudantes brasileiros entre 12 e 17 anos, sendo que houve tendência de os adolescentes mais novos apresentarem prevalências de sobrepeso e obesidade maiores do que os mais velhos em ambos os sexos (BLOCH et al., 2016).

1.1.3 Morbimortalidade

Além de ser considerado uma doença crônica, o excesso de peso é um importante fator de risco para outras doenças com altos índices de morbidade e mortalidade, como diabetes, doenças cardiovasculares, respiratórias e músculo esqueléticas e alguns tipos de câncer (WHO, 2000). No Brasil, as doenças crônicas não transmissíveis (DCNT) são a causa de 74% das mortes ocorridas em 2016, dentre as quais as que mais matam foram doenças cardiovasculares (28%), câncer (18%), doenças respiratórias crônicas (6%) e diabetes mellitus (5%) (WHO, 2018). Todas estas estão associadas, em maior ou menor grau, com a presença de excesso de

peso (WHO, 2000). Um dos mecanismos biológicos desta associação é explicado pelo fato do tecido adiposo não ser apenas uma reserva energética, mas um órgão endócrino, capaz de produzir diversas citocinas ou adipocitocinas que estão envolvidas no processo inflamatório (FONSECA-ALANIZ et al., 2007; LOPES, 2007). Outra explicação é que ocorre aumento do estresse oxidativo devido aos substratos da produção de energia pelas mitocôndrias e pela elevação da glicose circulante (SALMON, 2016).

Esses efeitos são observados inclusive na população mais jovem. Adolescentes com excesso de peso são mais susceptíveis a diversos problemas de saúde, como dislipidemia, hipertensão, resistência à insulina e síndrome metabólica, que até alguns anos atrás eram mais evidentes em adultos, além de complicações ortopédicas, síndrome do ovário policístico, apneia do sono, depressão, baixa autoestima, baixo desempenho acadêmico e menor qualidade de vida (WHO, 2016; CHENG et al., 2016; REILLY et al., 2011). Além disso, adolescentes obesos são cerca de cinco vezes mais propensos a serem adultos obesos, com maior chance de morbimortalidade (SIMMONDS et al., 2015).

Uma avaliação sistemática dos efeitos do IMC elevado sobre a saúde estima que o excesso de peso foi responsável por cerca de 4 milhões de mortes e 120 milhões de anos de vida ajustados por incapacidade em todo o mundo em 2015 (AFSHIN et al., 2017). Importantes reduções na expectativa de vida foram associadas com sobrepeso e obesidade. Entre não fumantes com 40 anos, estima-se uma redução de cerca de três anos na expectativa de vida devido ao sobrepeso e de sete anos em decorrência da obesidade. (PEETERS et al., 2003).

1.1.4 Custos associados ao excesso de peso

Além dos agravos à saúde dos indivíduos, o excesso de peso provoca um aumento significativo nos gastos diretos e indiretos com saúde, tornando-se um problema para a economia e os sistemas de saúde (BAHIA et al., 2012). Em 2014, o impacto econômico global da obesidade foi estimado em US\$ 2 trilhões ou 2,8% do Produto Interno Bruto (PIB) global (DOBBS et al., 2014), sendo observado um gradiente entre o aumento do IMC e os custos atribuíveis ao excesso de peso (KUDEL et al., 2018; DEE et al., 2014). Além de gastos com saúde, a obesidade também impõe custos sob a forma de perda de produtividade e crescimento econômico, como resultado da perda de dias de trabalho, menor produtividade, mortalidade e incapacidade permanente (KUDEL et al., 2018; DEE et al., 2014; DOBBS et al., 2014). No Brasil, mais de um milhão de dias de trabalho foram perdidos em 2001 devido a fatores relacionados à obesidade (SICHERI et al., 2007). Com o aumento da prevalência de excesso de peso no país, estima-se que esse número seja ainda maior atualmente, embora não tenham sido encontradas referências mais atuais.

Um estudo com dados da Pesquisa de Orçamentos Familiares (POF) 2008-2009 estimou que a presença de um indivíduo obeso no domicílio estava associada a um aumento de 19% nos gastos mensais per capita com medicamentos em relação a domicílios sem um morador obeso (CANELLA et al., 2016). Os custos diretos com assistência ao paciente associados a todas as doenças relacionadas ao excesso de peso no período de um ano no Sistema Único de Saúde (SUS) ultrapassaram US\$ 2,1 bilhões em 2010, sendo que 68% foram atribuíveis a hospitalizações e o restante, a

procedimentos ambulatoriais (BAHIA et al., 2012). Os maiores custos foram devido a doenças cardiovasculares (US\$ 747 milhões), seguidas por neoplasias relacionadas ao excesso de peso (US\$ 299,8 milhões), asma (US\$ 34 milhões), diabetes tipo 2 (US\$ 3,7 milhões) e osteoartrite (US\$ 3,9 milhões). Aproximadamente 10% do custo total foi atribuível exclusivamente ao sobrepeso e à obesidade (BAHIA et al., 2012). Estima-se que os custos com o excesso de peso dobrem até 2050 se a tendência de aumento em sua prevalência se mantiver, porém, uma redução de 5% na média do IMC em toda a população poderia economizar ao Brasil cerca de US\$ 57 bilhões nesse período (RTVELADZE et al., 2013).

1.2 ETIOLOGIA E FATORES ASSOCIADOS AO EXCESSO DE PESO

De maneira simplista, o excesso de peso é resultado do balanço energético positivo mantido ao longo do tempo (HILL, 2006). Ou seja, quando o consumo energético é maior que o gasto, cria-se um excedente de energia, que é acumulado na forma de tecido corporal, muitas vezes, tecido adiposo. Para perder peso, o gasto energético deve exceder a ingestão, e para ganhar peso, a ingestão deve exceder o gasto. Em nível populacional, cada incremento na ingestão energética de 24 kcal/dia (100 KJ/d) se associou a um aumento médio de cerca de um quilograma no peso corporal (HALL et al., 2011).

Porém, o que leva a esse desequilíbrio energético e, consequentemente, ao excesso de peso, é uma interação complexa entre componentes genéticos e influências ambientais, entre os quais se destacam mudanças nos padrões alimentares

e redução no nível de atividade física, muitas vezes influenciados por fatores socioeconômicos e comportamentais. (WHO, 2000; BRASIL, 2006).

Profundas mudanças sociais e econômicas geraram ambientes obesogênicos, que levaram o excesso de peso a aumentar em níveis muito além do controle de qualquer indivíduo isoladamente e fizeram com que ele passasse a ser considerado uma pandemia (MELDRUM et al., 2017). Essas mudanças, como o crescimento econômico, disponibilidade crescente de alimentos abundantes e baratos (muitas vezes, com alta densidade energética, ricos em sódio, açúcares e gorduras e pobres em nutrientes, como fibras, vitaminas e minerais), a industrialização e a urbanização vêm ocorrendo em países de alta renda desde o início do século XX, e atualmente essas características estão crescendo em países de baixa e média renda (HRUBY e HU, 2015).

Nas últimas décadas em diversos países, incluindo o Brasil, fatores associados ao contexto político, econômico, cultural e social, como o sistema agroalimentar, as formas de consumo e produção, a concentração de renda, a produção e manutenção das desigualdades sociais, entre outros, geraram modos de viver, morar, comunicar, trabalhar, cozinhar e se alimentar que resultaram em um ambiente obesogênico (WHO, 2000; CONSEA, 2015).

No entanto, os fatos de nem todos os que vivem em ambientes obesogênicos experimentarem o mesmo efeito de aumento do peso corporal e de diversos esforços para perda de peso em pessoas com excesso de peso não apresentarem os mesmos resultados indicam que há também influência de outros fatores, como genética e epigenética, história familiar, diferenças raciais e étnicas, além dos ambientes

socioeconômicos e socioculturais específicos de cada indivíduo (GORTMAKER et al., 2011; HRUBY e HU, 2015).

O **Quadro 2** resume alguns dos fatores de risco para o excesso de peso explorados na literatura (sem esgotar todas as possibilidades). Compreender como esses fatores interagem entre si e influenciam, em conjunto, o excesso de peso é a maior lacuna no conhecimento científico atualmente.

Quadro 2 – Fatores de risco associados positivamente ao excesso de peso.

Fatores individuais
<ul style="list-style-type: none"> - Consumo energético maior que a necessidade energética (balanço energético positivo) - Consumo excessivo de alimentos com alta densidade energética e baixa densidade de nutrientes (ex. <i>junk food</i>) - Consumo excessivo de bebidas açucaradas (ex. refrigerantes açucarados) - Hábitos e preferências alimentares inadequados (ex. padrão ocidental) - Baixo nível de atividade física - Comportamento sedentário (ex. elevado tempo de tela) - Distúrbios do sono (ex. apneia do sono, baixa qualidade/tempo de sono) - Desregulação do ritmo circadiano (ex. trabalhadores noturnos) - Predisposição genética / hereditabilidade (alterações monogênicas – ex: mutação no gene MC4R, LEP; poligênicas – ex: combinação de polimorfismos de nucleotídeo único (SNP)) - Exposições pré e perinatais (ex: dieta/ganho de peso inadequados da mãe na gestação) - Condições psicológicas desfavoráveis (ex. estresse, depressão, distúrbios alimentares) - Utilização de determinadas drogas (ex. esteróides, glicocorticóides) - Presença de doenças / desregulação endócrina (ex. síndrome de Cushing, Prader-Willi, hipotireoidismo)
Fatores Socioeconômicos
<ul style="list-style-type: none"> - Pobreza - Baixo nível de educação - Falta de acesso a informações e serviços de saúde - Falta de suporte social - Insegurança alimentar
Fatores Ambientais
<ul style="list-style-type: none"> - Urbanização - Falta de acesso a locais/programas que possibilitem prática de atividade física - Bairros com pouca andabilidade - Falta de opção de transporte - Formas inadequadas de produção e consumo de alimentos - Desertos alimentares / falta de acesso a alimentos - Exposição a grandes porções de alimentos - Exposição à mídia e ao marketing agressivo de alimentos - Moradia com ambiente alimentar inadequado - Contato com produtos químicos de desregulação endócrina (xenobióticos obesogênicos: diclorodifeniltricloroetano, ftalatos, tributil, bisfenol A) - Disbiose (ex: composição/funcionalidade da microbiota intestinal alterada)

Fontes: WHO, 2000; HRUBY e HU, 2015; BROUSSARD e CAUTER, 2016; HRUBY et al., 2016; KUMAR e KELLY, 2017; MELDRUM et al., 2017.

1.2.1 Aspectos dietéticos relacionados ao excesso de peso

A dieta é um dos componentes associados ao excesso de peso que é amplamente modificável. Mudanças na dieta ocorridas nas últimas décadas, seja qualitativa ou quantitativamente, têm sido fortemente associadas ao aumento do consumo energético, que tem como consequência um balanço energético positivo (POPKIN, 2001; MARCHIONI, 2012). Além disso, a alimentação está relacionada intimamente a outros fatores, como o perfil da microbiota intestinal e interação com as informações genéticas (USSAR et al., 2015; WANG et al., 2018).

Diversas evidências indicam a associação do consumo de determinados nutrientes, alimentos e bebidas com o ganho de peso. Por exemplo, o alto consumo de gorduras totais, sódio, colesterol e açúcar refinado e baixo consumo de fibra alimentar foi associado ao ganho excessivo de peso em diferentes populações (MISHRA et al., 2006; HU, 2008; MALTA et al., 2011).

Dados da coorte americana do Nurses' Health Study (NHS) indicam que o aumento da ingestão de energia proveniente das gorduras mono ou poliinsaturadas não foi associado ao ganho de peso no período de oito anos, enquanto o aumento do consumo de energia das gorduras animais, saturadas e *trans* foi positivamente associado, particularmente entre mulheres com excesso de peso (FIELD et al., 2007). Além disso, em um seguimento de 12 anos, mulheres que tiveram maior ingestão de grãos integrais ganharam menos peso do que mulheres com menor ingestão, enquanto aquelas com maior consumo de grãos refinados ganharam mais peso ao longo do tempo (LIU et al., 2003).

Em relação aos alimentos, o consumo aumentado de batatas (incluindo *chips*), grãos refinados, doces ou sobremesas, bebidas açucaradas, carnes vermelhas e processadas e frituras resultou em maior ganho de peso em um período de quatro anos, enquanto o maior consumo de frutas, legumes e verduras (FLV), grãos integrais, oleaginosas ou iogurte, em menor ganho de peso entre homens e mulheres de três coortes dos EUA (MOZAFFARIAN et al., 2011). Uma meta-análise com 22 estudos de coorte mostrou que cada incremento de uma porção no consumo de bebidas açucaradas (12 oz = 355 mL) estava associado a um aumento de 0,06 unidades no IMC de crianças e adolescentes e a um aumento de peso de 0,12 a 0,22 kg em adultos no período de um ano (MALIK et al., 2013).

Nas áreas metropolitanas do Brasil, entre 1974 e 2009, observou-se um declínio na aquisição de alimentos básicos e tradicionais da dieta brasileira, como o arroz e o feijão, e um aumento de até 400% no consumo de alimentos como biscoitos e refrigerantes, consumo excessivo de açúcar e insuficiente de frutas e hortaliças, além do aumento no teor de gorduras totais e saturadas da dieta (LEVY et al., 2005; LEVY et al., 2012).

Dados da POF 2008/2009 indicaram que houve aquisição alimentar excessiva de gorduras totais e saturadas e açúcar de adição e insuficiente de FLV na população urbana brasileira (LEVY et al., 2012). Resultados semelhantes foram observados na população do município de São Paulo: a média de energia proveniente dos açúcares de adição foi de 9,1% entre adultos e 8,4% entre idosos, a ingestão de lipídios apresentou-se acima do adequado em mais da metade da população, com média de ingestão de 31,9% do valor energético total (BUENO et al., 2012; SIMONI et al.,

2013). Além disso, 22% de adolescentes e 50% dos adultos desta mesma população não relataram o consumo de FLV no dia investigado (BIGIO et al., 2013).

1.2.1.1 Tamanho da porção

A quantidade de alimentos consumida nas refeições também pode estar envolvida no controle do peso corporal (LEDIKWE et al., 2005). Nas últimas décadas, houve aumento das porções comercializadas dos alimentos, nos tamanhos das porções em livros de receitas, bem como das quantidades consumidas por refeição, em paralelo ao aumento da prevalência de excesso de peso (BENTON, 2015).

Estudos conduzidos nos Estados Unidos (YOUNG e NESTLE, 2002; NIELSEN e POPKIN, 2003; SMICKLAS-WRIGHT et al., 2003; YOUNG e NESTLE, 2012), Holanda (STEENHUIS et al., 2009), Dinamarca (MATTHIESSEN, 2003) e Reino Unido (WRIEDEN et al., 2008) indicam o aumento no tamanho das porções de diversos alimentos comercializados, especialmente aqueles com elevada densidade energética, e destacam a introdução no mercado de porções gigantes (“*supersize*”). Apesar das evidências de aumento no tamanho das porções, estudo da *Food Standards Agency* da Inglaterra concluiu que a realidade é complexa, pois apesar da maioria dos itens ter aumentado de tamanho, outros mantiveram seus tamanhos originais ou até tornaram-se menores, disponíveis em embalagens com várias unidades em menores porções (CHURCH, 2008).

Além das porções comercializadas, houve aumento no tamanho das porções consumidas por refeição ao longo do tempo. Nos EUA, Nielsen e Popkin (2003) compararam os alimentos que foram responsáveis pelos maiores aumentos no consumo energético: petiscos, sobremesas, refrigerantes, sucos, batata-frita, *hamburgers*, *cheeseburgers*, pizza e comida mexicana. Esses alimentos representaram 18% das calorias consumidas em 1977-8 e 27,7% em 1994-6, sendo observado aumento no consumo energético no período. Neste estudo, o tamanho da porção aumentou para todos os itens avaliados, com exceção da pizza. Smiciklas-Wright et al. (2003) encontraram diferenças significantes nas quantidades consumidas entre 1989-91 e 1994-96 em um terço dos 107 alimentos que examinaram. A maior parte dos alimentos teve maior consumo em 1994-96, como refrigerantes, café, chás e cereais matinais, porém, alguns alimentos como margarina, maionese, frango, macarrão com queijo e pizza tiveram menores porções consumidas.

As diferenças observadas nas mudanças nos tamanhos das porções ao longo do tempo indicam que não há um padrão único de aumento ou redução, e ilustram que vários aspectos podem estar relacionados a essas variações, como cultura, economia, ambiente social, políticas alimentares, entre outros (BENTON, 2015). Este fato destaca a importância de monitorar as tendências em cada população específica, a fim de apoiar ações voltadas especificamente para cada grupo.

Apesar dos estudos epidemiológicos indicarem complexidade na relação entre porções de alimentos e excesso de peso, diversos estudos experimentais indicam que o consumo energético aumenta quando maiores porções são oferecidas aos

indivíduos (ROLLS et al., 2002; WANSINK e CHENEY, 2005; ROLLs et al., 2007; JEFFERY et al., 2007). Em uma meta-análise, Zlatevska e colaboradores (2014) demonstraram que dobrar o tamanho da porção de alimentos leva, em média, a um aumento de 35% no consumo energético. Além disso, o efeito do tamanho das porções pode persistir por vários dias (ROLLS et al., 2007), pois mesmo se sentindo mais satisfeitos, os indivíduos não compensam a energia ingerida a mais, ou seja, não reduzem as quantidades consumidas na refeição seguinte. Um ensaio clínico randomizado em um ambiente de trabalho demonstrou que a exposição a um almoço com maior porção (1600 kcal) durante um período de seis meses levou a um aumento significativo na ingestão de energia e ganho de peso (FRENCH et al., 2014).

Na população brasileira, um estudo com o Inquérito Nacional de Alimentação (INA-POF 2008/2009) investigando o tamanho das porções de bebidas consumidas no Brasil encontrou associação positiva entre o tamanho das porções de refrigerante e bebidas alcoólicas com excesso de peso (BEZERRA et al., 2018). Em adultos da cidade de São Paulo, o excesso de peso foi associado positivamente com maiores porções de pizza, carne vermelha, arroz, salgados e refrigerantes (PEREIRA et al, 2016).

1.2.1.2 Qualidade da dieta

O fato das pessoas terem uma dieta complexa, não apenas baseada em determinados nutrientes ou alimentos fez com que fosse desenvolvida uma abordagem que avalia os padrões da dieta de uma maneira global (KANT, 1996). Uma das formas de avaliar esses padrões é com a utilização de índices de qualidade

da dieta *a priori*, que são pontuações baseadas em um conjunto de componentes (sejam eles nutrientes, alimentos e/ou grupos de alimentos) com evidências de sua importância para uma dieta saudável, de acordo com recomendações nutricionais ou com sua associação com desfechos em saúde (KANT, 1996; ASGHARI et al., 2017). Esses índices têm como objetivo sintetizar as características do padrão alimentar de maneira quantitativa, a fim de possibilitar a avaliação de possíveis relações entre dieta e doenças crônicas, avaliar o consumo alimentar em nível populacional e/ou individual e monitorar os padrões alimentares e a adesão aos guias alimentares de populações (KANT, 1996; ASGHARI et al., 2017).

Ao longo da história da epidemiologia nutricional, diversos índices foram criados a partir de guias dietéticos, principalmente nos EUA e alguns países da Europa (JENKINS & GUTHRIE, 1984; KREBS-SMITH et al., 1987; KENNEDY et al. 1995; DREWNOWSKI et al., 1996; HUIJBREGTS et al. 1997; TRICHOPOULOU et al. 1995; PATTERSON et al., 1994; BOWMAN et al., 1998; HAINES et al., 1999; MCCULLOUGH et al., 2002; SERRA-MAJEM et al., 2004). Um dos primeiros índices com grande repercussão na literatura foi o *Diet Quality Index* (DQI), baseado nas recomendações dietéticas americanas do *Food and Nutrition Board* (PATTERSON et al. 1994). A pontuação do DQI varia de zero (dieta de excelente qualidade) a 16 pontos (dieta de má qualidade) e é determinada por componentes baseados em alimentos (frutas, verduras e legumes, cereais e leguminosas) e em nutrientes (gordura total, gordura saturada e colesterol, cálcio, sódio e proteína).

O *Healthy Eating Index* (HEI), proposto em 1995 pelo Departamento de Agricultura dos EUA, foi inspirado no DQI e se baseou nas recomendações do

Dietary Guidelines for Americans e na *Food Guide Pyramid* (KENNEDY et al. 1995). A pontuação do HEI é composta por 10 componentes (cereais totais, verduras e legumes, leite e derivados, frutas, carnes, gordura total e saturada, colesterol, sódio e variedade da dieta) e varia de zero (dieta de péssima qualidade) a 100 (dieta de ótima qualidade) pontos.

Em 2005, com a publicação da atualização do *Dietary Guidelines for Americans*, o HEI passou por revisão e foi desenvolvido o *Healthy Eating Index-2005* (HEI-05), com 12 componentes: frutas totais; frutas integrais; vegetais totais; vegetais verde escuros e alaranjados e leguminosas; cereais totais; cereais integrais; leite e derivados; carne, ovos e leguminosas; óleos; sódio; gordura saturada; e valor energético proveniente da ingestão de gordura sólida, álcool e açúcar de adição (gord_AA) (GUENTHER et al., 2007). Diferente dos índices anteriores, os componentes do HEI-05 são baseados em densidade energética (por mil quilocalorias), exceto para gordura saturada e para o valor energético proveniente do componente gord_AA, que são calculados de acordo com o percentual energético da dieta.

Uma atualização do HEI a cada cinco anos foi proposta, a fim de acompanhar as revisões do guia alimentar para a população dos EUA. Assim, houve uma revisão do índice em 2010 (HEI-2010; GUENTHER et al., 2013), sendo as principais alterações: a substituição dos componentes “verduras e legumes verde-escuros e alaranjados e leguminosas” e “cereais totais” pelos componentes “vegetais verdes e feijões” e “cereais refinados” e a adição dos componentes “frutos do mar e proteínas vegetais” e “ácidos graxos”. Recentemente, foi publicado o HEI-2015, com base nas recomendações do *Dietary Guidelines for Americans 2015-2020* (KREBS-SMITH et

el., 2018), cujos componentes são os mesmos do HEI-2010, com excessão da gordura saturada ($\leq 8\%$ do VET) e do açúcar de adição ($\leq 6,5\%$ do VET), que substituem o componente gord_AA, resultando em 13 componentes.

Vários índices foram desenvolvidos a partir do HEI americano e validados para outras populações (SCHAP et al., 2017), incluindo o Índice de Qualidade da Dieta (IQD) proposto por Fisberg et al. (2004) para a população brasileira, que foi posteriormente revisado por PREVIDELLI et al. (2011), gerando o IQD-R, com base nas recomendações nutricionais publicadas no Guia Alimentar para a População Brasileira (2006). Em publicação recente com a população de São Paulo, observa-se que houve uma melhora gradual na qualidade da dieta entre os anos de 2003 (média do IQD-R = 54,7; EP = 0,51) e 2015 (média do IQD-R = 58,4; EP = 0,39) (MELLO et al., 2018). Porém, os adolescentes foram o grupo com pior qualidade da dieta em todo o período avaliado, sendo que houve redução da qualidade neste grupo (média do IQD-R passou de 50,8; EP = 0,57 em 2003 para 50,3; EP = 0,52 em 2008), seguida de melhora em 2015 (média do IQD-R = 54,5; EP = 0,56).

Outro índice frequentemente utilizado e adaptado para outras populações é o *Mediterranean Diet Score* (MDS; TRICHOPOULOU et al. 1995), que foi baseado nos padrões alimentares da região do Mediterrâneo, associados à redução da incidência e mortalidade por doenças cardiovasculares. Dentre os componentes que caracterizam essa dieta, encontram-se: baixo consumo de carne e produtos cárneos, consumo moderado de etanol (principalmente do vinho) e elevado consumo de vegetais, frutas, nozes, legumes, peixe e azeite (SHEN et al., 2015).

Na tentativa de melhorar a associação com doenças crônicas em relação ao HEI, McCullough et al. (2002) propuseram o *Alternate Healthy Eating Index*

(AHEI), que foi baseado em uma compilação de evidências de estudos epidemiológicos com alimentos e nutrientes associados ao maior ou menor risco para doenças crônicas. O AHEI incorpora vários aspectos do HEI original e, portanto, alguns componentes correspondem às diretrizes dietéticas existentes (por exemplo, maior ingestão de frutas e verduras), além de pontuar quantitativamente orientações dietéticas qualitativas (por exemplo, consumir mais peixe, aves e grãos integrais, e se consumir bebida alcoólica, que seja com moderação), sendo que a escolha de seus componentes e a forma de pontuação foram decididas a priori, com base em discussões com pesquisadores na área de nutrição (CHIUVE et al., 2012).

Outro índice que teve como base a associação da qualidade da dieta com doença foi o índice que mede a aderência ao *Dietary Approaches to Stop Hypertension* (DASH), em que é proposta uma dieta rica em frutas e vegetais, moderada em produtos lácteos com baixo teor de gordura e pobre em proteína animal, mas com uma quantidade substancial de proteína vegetal proveniente de legumes e nozes, a fim de reduzir substancialmente a pressão arterial sistólica e diastólica entre hipertensos e normotensos (FUNG et al., 2008).

Além dos índices previamente descritos, vários outros foram publicados com diversas populações (ARVANITI & PANAGIOTAKOS, 2008; FRANSEN & OCKÉ, 2008) e têm sido utilizados em estudos epidemiológicos a fim de caracterizar a dieta da população e fazer associações com uma série de variáveis, como, por exemplo, características sociodemográficas, condições de saúde e mortalidade (BEGHIN et al., 2014; MCLNERNEY et al., 2016; SCHWINGSHACKL et al., 2018).

Alguns índices de qualidade da dieta têm se associado negativamente com excesso de peso, especialmente em estudos dos EUA (ASGHARI et al., 2017). Dados das coortes americanas NHS e *Health Professionals Follow-Up Study* (HPFS) mostram que maior adesão ou aumento da adesão a qualquer um dos três índices avaliados (*Alternate Mediterranean Diet* - AMD, *Alternate Health Eating Index*-2010 - AHEI-2010, e *Dietary Approaches to Stop Hypertension* - DASH) foi associada ao menor ganho de peso em um período de quatro anos em ambos os sexos, especialmente em mulheres jovens ou indivíduos com excesso de peso (FUNG et al., 2015). Em revisão sistemática com 34 estudos, a associação do peso corporal com o *Health Eating Index* (HEI) original e outras versões, incluindo o AHEI-2010 e o HEI-2005, foi examinada em 13 estudos, dos quais 10 apresentaram associações negativas do índice com o peso corporal. Em geral, o HEI foi um melhor preditor de obesidade em homens do que em mulheres (ASGHARI et al., 2017).

Uma meta-análise recente que avaliou 34 estudos de coorte com adultos observou que dietas com maior qualidade (medidas utilizando os índices HEI-2005, AHEI-2010 e DASH) foram associadas com uma redução significativa no risco de mortalidade por todas as causas (22%), por doenças cardiovasculares (22%), câncer (16%), diabetes tipo 2 (18%) e doenças neurodegenerativas (15%) (SCHWINGSHACKL et al., 2018).

Na população jovem, apesar da importância da qualidade de dieta, evidências que associam padrões alimentares *a priori* aos desfechos em saúde são escassas. Em uma revisão sistemática que investigou essas associações em populações pediátricas, o peso corporal foi o desfecho de saúde mais frequentemente investigado, sendo que a maioria dos estudos foi conduzida em países desenvolvidos (MARSHALL et al.,

2014). No entanto, as evidências são inconsistentes, com alguns estudos encontrando associações negativas enquanto outros encontraram associações positivas, o que pode ser resultado de diferenças no delineamento dos estudos, nos ajustes realizados ou na ampla variação na metodologia dos índices utilizados. Ainda assim, estudos de coorte indicam que uma dieta de alta qualidade na adolescência e entre adultos jovens é importante para a manutenção da saúde cardiovascular e prevenção de doenças cardiovasculares futuras (DAHM et al., 2016; STEFFEN et al., 2014; LIU et al., 2012).

2 JUSTIFICATIVA

A necessidade de programas para prevenção e tratamento do excesso de peso e de doenças associadas é inquestionável, tendo em vista sua elevada prevalência e seus prejuízos à saúde da população. A presente tese propõe apresentar informações atualizadas sobre a distribuição, magnitude e mudanças na prevalência do excesso de peso ao longo dos anos, bem como seus fatores associados considerando uma amostra representativa da população da maior cidade do Brasil, uma das cidades mais populosas do mundo. Essas informações são essenciais para auxiliar tomadores de decisão e pesquisadores a determinar grupos-alvo e identificar ações prioritárias para intervenções a fim de diminuir o excesso de peso na população.

Outro ponto relevante do presente trabalho é a investigação de um dos maiores determinantes modificáveis do excesso de peso: a dieta. Embora mudanças nos padrões alimentares dos brasileiros tenham ocorrido nas últimas décadas em paralelo

ao aumento da prevalência de excesso de peso (POPKIN, 2001), não há evidências sobre diferenças no tamanho das porções de alimentos consumidas ao longo do tempo. Embora seja extremamente complexo estabelecer uma associação entre o tamanho da porção e o excesso de peso em estudos epidemiológicos, visto que muitos fatores além do tamanho da porção influenciam o consumo energético, ajustar as análises por variáveis como o número de refeições e a densidade energética da dieta permite uma investigação mais ampla dessa associação.

Além disso, investigar a associação da qualidade da dieta com excesso de peso e fatores de risco cardiometabólico entre os adolescentes é de extrema importância, dado sua elevada e crescente prevalência em diversas populações, associada à menor qualidade da dieta em relação às demais faixas etárias e à limitada quantidade de informações científicas relativas a este grupo. Ainda, a possibilidade de identificar diferenças e semelhanças na qualidade da dieta e sua associação com esses aspectos em adolescentes residentes no Brasil e nos EUA - dois países com elevada prevalência de excesso de peso - pode contribuir para o avanço do conhecimento atual sobre essas relações, principalmente por não estarem bem estabelecidas em adolescentes (FUNTIKOVA et al., 2015; MARSHALL et al., 2014).

3 OBJETIVOS

3.1 OBJETIVO GERAL

Avaliar a prevalência e projeção de sobrepeso e obesidade na população, assim como modificações na dieta entre os anos de 2003 e 2015. Além de investigar a associação da qualidade da dieta e risco cardiometabólico em adolescentes.

3.2 OBJETIVOS ESPECÍFICOS

1. Verificar a prevalência de excesso de peso na população da cidade de São Paulo nos anos de 2003, 2008 e 2015, segundo características demográficas e socioeconômicas;
2. Analisar os fatores associados ao excesso de peso nesta população;
3. Estimar a predição de sobrepeso e obesidade para os anos de 2020, 2025 e 2030;
4. Avaliar se houve diferença na composição da dieta (energia e macronutrientes), frequência de consumo e tamanho das porções de alimentos nessa população entre os anos de 2003 e 2015, comparando o consumo da população sem e com excesso de peso;
5. Verificar a prevalência de obesidade central e fatores de risco cardiometabólico de adolescentes da cidade de São Paulo e em latinos vivendo nos EUA, comparando a população sem e com excesso de peso;

6. Comparar a composição da dieta (energia, macro e micronutrientes) e a qualidade da dieta entre adolescentes sem e com excesso de peso;
7. Avaliar a associação da qualidade da dieta com excesso de peso, obesidade central e fatores de risco cardiometabólico entre os adolescentes.

4 MÉTODOS

4.1 ANTECEDENTES

Este estudo utilizará dados secundários do projeto de pesquisa intitulado “Inquérito de Saúde do Município de São Paulo” (ISA-Capital) e de seu complemento “Inquérito de Saúde de São Paulo com foco em Nutrição” (ISA-Nutrição), assim como do “Hispanic Community Children’s Health Study/Study of Latino Youth” (SOL-Youth).

O ISA-Capital é coordenado pelo Professor Chester Luiz Galvão César, da Faculdade de Saúde Pública da Universidade de São Paulo, em parceria com a Secretaria Municipal de Saúde de São Paulo. É um projeto realizado periodicamente, com o objetivo de avaliar as condições de vida, situação de saúde e uso de serviços de saúde em amostra representativa de moradores do município de São Paulo. Em suas edições, o ISA-Capital foi financiado pela Secretaria Municipal de Saúde (2003 e 2008 sem número; 2015 número: 2013-0.235.936-0) e Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, processo 98/14099-7) e conta com a aprovação pelos Comitês de Ética em pesquisa da Secretaria Municipal de Saúde e

da Faculdade de Saúde Pública (CAAE nº 0030162000-08; CAAE nº 32344014.3.3001.0086).

A área de nutrição do ISA-Capital, denominada “Inquérito de Saúde de São Paulo com foco em Nutrição” (ISA-Nutrição), é coordenada pela Professora Regina Mara Fisberg. O objetivo do ISA-Nutrição é avaliar o consumo alimentar e outros fatores de estilo de vida modificáveis em uma subamostra do ISA-Capital, com indivíduos com 12 anos ou mais e, no caso de mulheres, que não estivessem grávidas ou amamentando no período da coleta. Em suas diferentes versões, o ISA-Nutrição conta com apoio financeiro da Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, processos 2007/51488-2; 2009/15831-0; 2012/22113-9) e Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, processos 502948/2003-5, 481176/2008-0; 473100/2009-6; 301597/2017-0; 472873/2012-1; 402674/2016-2; 301597/2017-0) e aprovação pelos Comitês de Ética em pesquisa da Secretaria Municipal de Saúde e da Faculdade de Saúde Pública (COEP nº 275/09; CAAE nº 30848914.7.0000.5421).

O “Hispanic Community Children’s Health Study/Study of Latino Youth” (SOL-Youth) é um estudo com jovens latinos/hispânicos que vivem nos EUA e tem como objetivo investigar a aculturação e fatores psicossociais, verificar diferenças entre pais e filhos, além de avaliar a associação entre o comportamento dos pais e dos jovens, assim como sua influência no risco cardiometabólico. O estudo foi aprovado pelos comitês de ética referentes a cada um dos centros de estudo e obteve financiamento das seguintes agências: National Heart, Lung and Blood Institute (K01-HL120951, N01-HC65233, N01-HC65234, N01-HC65235, N01-HC65236, N01-HC65237); National Institute on Minority Health and Health Disparities;

National Institute on Deafness and Other Communication Disorders; National Institute of Dental and Craniofacial Research; National Institute of Diabetes and Digestive and Kidney Diseases; National Institute of Neurological Disorders and Stroke; NIH Institution-Office of Dietary Supplements.

4.2 DELINEAMENTO E POPULAÇÃO DE ESTUDO

O ISA-Capital é um estudo com delineamento transversal, de base populacional, com amostra probabilística de indivíduos residentes em domicílios permanentes localizados na área urbana do município de São Paulo. Nos estudos de 2003, 2008 e 2015, as informações foram coletadas por meio de inquéritos domiciliares e telefônicos.

O SOL-Youth é um estudo de delineamento transversal, com amostra composta por filhos dos participantes do Hispanic Community Health Study/Study of Latinos (HCHS/SOL), o maior estudo de coorte de base populacional com 16.415 adultos latinos/hispânicos de 18 a 74 anos que vivem em quatro regiões do EUA: Bronx, Chicago, Miami, e San Diego. Crianças e adolescentes entre 8 e 16 anos no período de coleta de dados do HCHS/SOL que moravam com pelo menos um dos pais ou guardiões legais participantes do HCHS/SOL foram convidadas a participar do SOL-Youth. As informações foram coletadas por meio de visitas a um dos centros de pesquisa e inquéritos telefônicos entre os anos de 2012 e 2014, com 1.600 participantes.

4.3 CASUÍSTICA

ISA-Capital 2003: O plano de amostragem foi baseado em amostra probabilística complexa, representativa para oito domínios de sexo e idade: crianças (1 a 11 anos); adolescentes (12 a 19 anos) do sexo feminino e masculino; adultos (20 a 59 anos) de ambos os sexos; e idosos (60 anos ou mais) de ambos os sexos. O tamanho da amostra foi definido de forma a permitir a estimativa de uma proporção de 50% com erro de amostragem de 6%, nível de significância de 5% e efeito de delineamento de 1,5, e ampliado para considerar possíveis perdas. O sorteio da amostra ocorreu por conglomerados em dois estágios: os setores censitários urbanos constituíram as unidades primárias de amostragem (UPAS) e os domicílios, as secundárias. A amostra inicial resultou em 3.357 indivíduos (843 crianças, 847 adolescentes, 795 adultos, 872 idosos).

Para avaliação do consumo alimentar no ISA-capital 2003 (**ISA-Nutrição 2003**), foram entrevistados 2.398 indivíduos com 12 anos ou mais. Destes, 2.376 responderam ao questionário socioeconômico e dietético (814 adolescentes, 746 adultos, 816 idosos).

ISA-Capital 2008: Tanto os domínios amostrais como os procedimentos para o sorteio foram os mesmos utilizados no ISA-Capital 2003. O cálculo amostral levou em consideração permitir a estimativa de uma proporção de 50% com erro de amostragem de 7%, nível de significância de 5% e efeito de delineamento de 1,5, e ampliado para considerar possíveis perdas. A amostra totalizou 3.271 indivíduos (580 crianças, 605 adolescentes, 1.162 adultos, 924 idosos).

Em subamostra do ISA-Capital 2008 (**ISA-Nutrição 2008**) com 1.662 indivíduos com 12 anos ou mais (560 adolescentes, 585 adultos, 517 idosos) foram coletadas informações de consumo alimentar. Além da avaliação do consumo alimentar, amostras de sangue para realização de exames bioquímicos, assim como medidas de pressão arterial, peso, altura e circunferência de cintura foram aferidas em 750 indivíduos (158 adolescentes, 302 adultos e 290 idosos).

ISA-Capital 2015: Os procedimentos para o sorteio foram os mesmos utilizados nos ISA-Capital anteriores, porém os domínios incluíram tanto os domínios geográficos (Norte, Sul, Leste, Sudeste e Centro-Oeste) como demográficos (adolescentes; adultos do sexo masculino e do sexo feminino; idosos). O tamanho da amostra foi definido a fim de permitir a estimativa de uma proporção de 50%, efeito de delineamento de 2, nível de significância de 5% e erro de amostragem de 5%, e ampliado para considerar possíveis perdas. Foram entrevistados, no total, 4.043 indivíduos (859 adolescentes, 2.165 adultos, 1.019 idosos) (ALVES et al., 2018).

Foram coletados dados de consumo alimentar (**ISA-Nutrição 2015**) em uma subamostra de 1.737 indivíduos (553 adolescentes, 642 adultos, 542 idosos), sendo que, destes, 901 forneceram amostras biológicas e tiveram dados antropométricos e de pressão arterial aferidos (291 adolescentes, 302 adultos, 308 idosos) (FISBERG et al., 2018).

SOL-Youth: A seleção dos participantes derivou do estudo de coorte multicêntrico HCHS/SOL, cuja descrição está descrita no relatório publicado por Sorlie et al. (2010). Resumidamente, o HCHS/SOL recrutou adultos

autoidentificados como hispânicos ou latinos de uma amostra aleatória de domicílios de comunidades no Bronx, NY; Chicago, IL; Miami, FL e San Diego, CA. Os locais foram selecionados a fim de que a amostra consistisse em pelo menos 2.000 pessoas de cada uma das seguintes origens: mexicanos, porto-riquenhos e dominicanos, cubanos e central e sul-americanos. A amostragem foi definida para que tivesse poder para estimar a prevalência e distribuição de fatores de risco, estratificada por local de origem e outras características demográficas relevantes, assim como avaliar a associação entre os fatores de risco de desfechos em saúde. Todas as crianças e adolescentes sem morbidades sérias, físicas ou cognitivas, entre 8 e 16 anos que moravam ao menos cinco dias por semana e nove meses por ano com pai, mãe ou guardião legal participante do HCHS/SOL foram convidadas a participar do SOL-Youth, totalizando 1.600 indivíduos.

4.4 TAMANHO DA AMOSTRA

4.4.1 Primeiro Manuscrito

Para determinar a prevalência de sobrepeso e obesidade na população de São Paulo nos anos de 2003, 2008 e 2015, verificar os fatores associados e estimar a prevalência para os próximos anos, foram utilizados dados de todos os indivíduos do ISA-Capital com 12 anos ou mais e com dados antropométricos, de sexo e idade completos. Dessa forma, foram avaliados 2.144 indivíduos (711 adolescentes de 12 a 19 anos, 711 adultos de 20 a 59 anos, e 722 idosos com 60 anos ou mais) do ISA-Capital 2003; 2.599 indivíduos (569 adolescentes, 1.141 adultos, e 889 idosos) do

ISA-Capital 2008; 3.939 indivíduos (822 adolescentes, 2.126 adultos, e 991 idosos) do ISA-Capital 2015. A amostra final do primeiro manuscrito totalizou 8.682 indivíduos (2.102 adolescentes, 3.978 adultos, e 2.602 idosos).

4.4.2 Segundo Manuscrito

Para o segundo manuscrito, com o objetivo avaliar a associação entre excesso de peso e o tamanho da porção de alimentos, além de verificar diferenças entre os anos de 2003, 2008 e 2015 no tamanho da porção consumida pelos residentes de São Paulo, foram utilizados apenas indivíduos da subamostra do ISA-Capital que possuíam informações dietéticas (ISA-Nutrição): 2.398 indivíduos do ISA-Nutrição 2003, 1.662 indivíduos do ISA-Nutrição 2008 e 1.737 do ISA-Nutrição 2015. Indivíduos com informações antropométricas necessárias para a estimativa do índice de massa corporal (IMC) incompletas foram excluídos da análise, resultando em 2.100, 1.586 e 1.689 indivíduos, respectivamente. A fim de assegurar a qualidade dos dados, valores extremos de consumo energético (abaixo do percentil 1 e acima do percentil 99 por sexo) foram excluídos da análise, resultando em 2.060, 1.556 e 1.654 indivíduos em cada ano do ISA-Nutrição (MATTEI et al., 2016; CASAGRANDE et al., 2018). Sendo assim, a amostra final para o segundo manuscrito foi de 5.270 participantes: 1.711 adolescentes, 1.865 adultos e 1.143 idosos.

4.4.3 Terceiro Manuscrito

O terceiro manuscrito utilizou dados de adolescentes do ISA-Nutrição 2015 (n=290) para comparar a composição e a qualidade da dieta entre adolescentes sem e com excesso de peso e avaliar a associação da qualidade da dieta com a presença de excesso de peso, adiposidade central e fatores de risco cardiometabólico. Esse manuscrito foi resultado do doutorado sanduíche, que permitiu fazer uma comparação com os adolescentes do estudo SOL-Youth com informação de consumo alimentar (n=1.466).

Para que a comparação entre estudos fosse apropriada, foram utilizados apenas dados dos adolescentes da mesma faixa etária: 12 a 16 anos, com informações dietéticas, antropométricas e sociodemográficas (n=191 para o ISA-Nutrição e n=793 para o SOL-Youth). Além disso, valores extremos de consumo energético (abaixo do percentil 1 e acima do percentil 99 por sexo) foram excluídos da análise (MATTEI et al., 2016; CASAGRANDE et al., 2018), resultando na amostra final do terceiro manuscrito: 189 adolescentes do ISA-Nutrição 2015 e 787 adolescentes do SOL-Youth.

4.5 COLETA E PROCESSAMENTO DE DADOS

4.5.1 Inquéritos de Saúde de São Paulo

4.5.1.1 Dados sociodemográficos e de estilo de vida

Nos inquéritos de São Paulo, a coleta de informações demográficas, socioeconômicas, de morbidade referida, uso de medicamentos e de serviços de saúde, assim como de estilo de vida (tabagismo, consumo de bebida alcoólica, hábito alimentar e prática de atividade física) foi realizada no domicílio por meio de questionário estruturado aplicado por entrevistadores treinados ou no momento do contato telefônico nos estudos ISA-Capital 2003 (março a dezembro de 2003), ISA-Capital 2008 (setembro de 2008 a março de 2009) e ISA-Capital 2015 (setembro de 2014 a dezembro de 2015).

A renda familiar total foi obtida pela soma da renda de cada indivíduo no domicílio, incluindo salários, aposentadorias, benefícios do governo, pensões, bolsas, renda de aluguel, entre outros. O total foi dividido pelo número de pessoas no domicílio, a fim de estimar a renda familiar *per capita*. Para fins de análise, essa variável foi categorizada como ≤ 1 salário mínimo ou > 1 salário mínimo. O valor do salário mínimo em 2003 era de R\$ 240,00; em 2008 era R\$ 415,00 e R\$ 788,00 em 2015.

Perguntas sobre tabagismo, número e frequência de cigarros fumados por dia foram realizadas para definir a variável tabagismo. Aqueles que referiram fumar

atualmente pelo menos um cigarro por dia, todos os dias, há pelo menos um mês, foram considerados fumantes. Os que se referiram não fumar atualmente, mas já fumaram pelo menos um cigarro por dia, todos os dias, por pelo menos um mês no passado foram considerados ex-fumantes (FERRARI et al., 2017).

O consumo de bebida alcoólica foi avaliado nos ISA-Capital 2003 e 2008 usando o “*Cut Down, Annoyed by Criticism, Guilty and Eyeopener*” – CAGE (EWING, 1984) e no ISA-Capital 2015, usando o “*Alcohol Use Disorders Identification Test*” – AUDIT (BABOR et al., 2001), validado no Brasil (LIMA et al., 2005), associados a questões complementares.

Os dados sobre atividade física foram obtidos por meio da aplicação do Questionário de Atividade Física Internacional – IPAQ Longo, validado no Brasil (MATSUDO et al., 2001), com perguntas sobre duração, frequência e intensidade de atividades físicas ocupacional, de lazer, domésticas e de transporte. Os indivíduos foram classificados como "atinge a recomendação" ou "não atinge a recomendação" de acordo com as recomendações mais recentes para a atividade física global da OMS (WHO, 2010) para cada estágio da vida: ≥ 420 min/semana, incluindo 60 min/dia para adolescentes e ≥ 150 min/semana para adultos e idosos.

4.5.1.2 Dados antropométricos

No estudo ISA-Capital 2003 as medidas de peso e altura foram referidas na entrevista domiciliar. Já nos estudos ISA-Capital 2008 e ISA-Capital 2015 as medidas foram referidas e nos estudos ISA-Nutrição 2008 e ISA-Nutrição 2015,

foram aferidas. Em visita domiciliar, foram aferidos peso, estatura e circunferência da cintura, por um técnico de enfermagem, capacitado de acordo com os procedimentos de aferição recomendados pela OMS (WHO, 1995) e adotados pelo Sistema de Vigilância Alimentar e Nutricional (SISVAN, 2004). Todos os procedimentos foram sistematizados em um manual para treinamento e consulta do técnico de enfermagem.

Peso e estatura foram aferidos em duplicata, com o indivíduo descalço e vestindo roupas leves. Para a aferição do peso, em quilogramas, utilizou-se balança digital calibrada, do tipo plataforma (Tanita®, modelo HD-313, capacidade máxima de 150 quilogramas, precisão de 100 gramas), posicionou-se o indivíduo no centro da plataforma da balança, em postura ereta, os pés paralelos e unidos, e com os braços ao longo do corpo. Para a medição da estatura, em centímetros, utilizou-se estadiômetro portátil afixado em parede lisa e sem rodapé (Seca®, modelo 208, medição máxima 200 centímetros, precisão de 0,1 centímetros). O indivíduo, em postura ereta, foi posicionado segundo o plano de Frankfurt de modo a encostar calcanhares, panturrilhas, nádegas, ombros e a parte posterior da cabeça na superfície vertical do estadiômetro. A circunferência da cintura foi medida com fita métrica inextensível, posicionada acima do ponto médio, entre o último arco costal e a crista ilíaca dos participantes em pé, durante a expiração.

Os valores médios de peso e estatura de cada participante foram utilizados para calcular o índice de massa corporal (IMC). Os valores do IMC foram usados para classificar o estado nutricional de acordo com critérios para cada estágio da vida. Adolescentes foram considerados com sobrepeso quando o valor de IMC-para-

idade estava entre 1DP e 2DP (equivalente ao IMC 25 kg/m² aos 19 anos), e obesos quando o IMC-para-idade estava acima de 2 DP (equivalente ao IMC 30 kg/m² aos 19 anos) (WHO, 2007). Entre adultos, foi considerado sobrepeso quando $25 \leq \text{IMC} < 30 \text{ kg/m}^2$ e obesidade quando $\text{IMC} \geq 30 \text{ kg/m}^2$ (WHO, 2000). Idosos foram classificados com sobrepeso ($28 < \text{IMC} < 30 \text{ kg/m}^2$) ou obesidade ($\text{IMC} \geq 30 \text{ kg/m}^2$) de acordo com os pontos de corte recomendados pela Organização Pan Americana de Saúde (OPAS), no Estudo Saúde, bem-estar e envelhecimento (SABE), com países latino-americanos, incluindo o Brasil (LEBRÃO et al., 2003). O termo “excesso de peso” foi utilizado para se referir a sobrepeso e obesidade em conjunto.

No terceiro manuscrito, a fim de possibilitar uma melhor comparação entre os adolescentes brasileiros e latinos vivendo nos EUA, a classificação do estado nutricional dos adolescentes levou em consideração os pontos de corte da *World Obesity Federation* (COLE et al., 2000). Estes são baseados internacionalmente, visto que a população de referência foi obtida pela média de uma mistura heterogênea de pesquisas de diferentes países, incluindo EUA e Brasil. Os pontos são específicos para cada sexo e idade, atingindo os pontos de corte para adultos de um IMC de 25 e 30 kg/m² para sobrepeso e obesidade, respectivamente, aos 18 anos de idade. A circunferência da cintura foi utilizada para diagnosticar obesidade central, quando a medida estava acima do percentil 90, específico para sexo e idade (FRYAR et al., 2012).

As informações referidas foram utilizadas para que não houvesse perda amostral significativa, visto que as medidas foram aferidas apenas nos indivíduos participantes do ISA-Nutrição 2008 e ISA-Nutrição 2015. Sabe-se que a utilização

de peso e altura relatados pode contribuir com possíveis erros de mensuração, sendo necessário verificar a confiabilidade dos dados. Logo, foi realizado estudo prévio com a população do estudo ISA-Nutrição 2008, no qual foi observada alta correlação intraclasse entre as medidas de peso ($r>0,94$) e IMC ($r>0,85$) referidas e aferidas, bem como boa concordância entre as medidas de peso, altura e IMC. Os percentuais de sensibilidade ($>91\%$) e especificidade ($>83\%$) para classificação de IMC foram considerados elevados, sendo, portanto, factível a utilização destes parâmetros (CARVALHO et al., 2014).

4.5.1.3 Dados de pressão arterial

No ISA-Nutrição 2015, a pressão arterial foi aferida utilizando um dispositivo automático (Omron, modelo HEM-712C, Omron Healthcare, Inc., Kyoto, Japão). Duas medidas de pressão arterial foram realizadas com manguito adequado para a circunferência braquial dos participantes. As medidas foram tomadas após os participantes descansarem por cinco minutos em posição sentada, com o braço apoiado no nível do coração. A pressão arterial foi medida inicialmente no braço direito e, um minuto após a primeira medição, foi avaliada no braço esquerdo. Uma medida adicional foi obtida no braço com o maior valor. Se houvesse diferença maior que 10% entre as medidas, uma terceira medida foi realizada. Os resultados das pressões sistólica e diastólica foram obtidos pelas médias aritméticas aferidas, em mmHg.

4.5.1.4 Dados dietéticos

As informações sobre alimentação foram obtidas por meio da aplicação de um recordatório alimentar de 24 horas (R24h) em toda a amostra do ISA-Nutrição 2008 e do ISA-Nutrição 2015, e de um segundo R24h em uma subamostra de cada inquérito.

O primeiro R24h foi aplicado no domicílio, segundo os procedimentos padronizados pelo Multiple Pass Method (MPM), com o objetivo de contribuir para manter a atenção do indivíduo, facilitando que recorde os alimentos e bebidas consumidos e os relate de maneira detalhada (MOSHFEIGH et al., 2008) (Figura 1). Os indivíduos foram orientados a informar as quantidades em medidas caseiras e descrever o maior nível de detalhes possível, incluindo ocasiões de ingestão alimentar, horários das refeições, formas de preparo, temperos e marcas comerciais.

Figura 1 – Passos para coleta do R24h.

Extraído de: FISBERG e MARCHIONI, 2012.

A padronização na coleta de dados foi realizada por meio de treinamento dos entrevistadores, utilização de formulário padrão para aplicação do R24h e manual explicativo para seu preenchimento (FISBERG e MARCHIONI, 2012). As coletas representaram aleatoriamente todos os dias da semana e estações do ano para obtenção dos dados de consumo alimentar em cada um dos inquéritos.

As informações de consumo foram revistas para identificar eventuais falhas no preenchimento e para converter as medidas caseiras dos alimentos e bebidas em unidades de peso ou volume. A padronização e a quantificação dos alimentos e preparações foram realizadas segundo as recomendações de FISBERG e VILLAR (2002) e PINHEIRO et al. (2008).

O programa NDSR – Nutrition Data System for Research (versão 2014, NCC, Universidade de Minnesota, Minneapolis), cuja base de dados é originada da tabela de composição do *United States Department of Agriculture* (USDA), foi utilizado para a obtenção dos valores nutricionais. O software possui uma série de recursos que auxiliam na entrada de dados, além das vantagens de ter mais de 18.000 alimentos e exportar mais de nove tipos de arquivos, que permitem a análise tanto de nutrientes quanto de alimentos e refeições em nível individual (NCC, 2011). Como o programa utiliza uma base de dados americana, foi feita uma lista com a tradução de mais de 700 alimentos, bebidas, preparações e métodos de preparo utilizados pela população paulistana. Além disso, o valor nutricional dos alimentos presentes no programa foi confrontado com o valor nutricional dos alimentos disponíveis nas tabelas nacionais, considerando o modo de preparo dos alimentos (TACO - Unicamp, 2004 e TBCA - Faculdade de Ciências Farmacêuticas da USP, 2017). Apenas os alimentos que obtiveram percentuais de concordância entre 80% e 120% dos valores de energia e macronutrientes foram utilizados. Algumas preparações tipicamente brasileiras, que não constavam no programa, foram incluídas utilizando as padronizações de receitas (FISBERG e VILLAR, 2002). Um padrão de digitação foi utilizado para inserção de todos os alimentos consumidos no programa (FISBERG e MARCHIONI, 2012).

A segunda medida do R24h foi aplicada para uma subamostra nos estudos ISA-Nutrição 2008 e ISA-Nutrição 2015, em dias não consecutivos, seguindo os mesmos padrões citados anteriormente. A coleta do segundo R24h foi realizada por telefone e o recordatório foi digitado diretamente no programa NDSR e, por isso,

denominado *Automated Multiple Pass Method* (MOSHFEGH et al., 2008). Neste caso, os relatos foram gravados para posterior conferência.

Após a formação do banco de dados, foi feita consistência dos dados digitados, em que a ingestão alimentar dos indivíduos foi analisada cuidadosamente, sendo observados, conferidos e, caso necessário, corrigidos todos os valores inconsistentes de energia (menos de 800 ou mais de 4000 kcal), gramas e outros itens, a fim de evitar erros de sub ou superestimação, sendo que nenhum R24h foi excluído da análise (FISBERG e MARCHIONI, 2012).

4.5.1.4.1 Agrupamento de alimentos e determinação das porções

Para avaliação do tamanho das porções dos alimentos, os cerca de 1400 alimentos relatados nos dois R24h foram agrupados segundo seu valor nutricional, hábitos alimentares da população paulistana e dados da literatura em 46 grupos alimentares (**Anexo 1**). Devido à dificuldade em mensurar precisamente o tamanho das porções de sal, azeite, vinagre, óleo, molhos e condimentos, foi necessário padronizar as quantidades relatadas, introduzidas no software de forma sistemática. Consequentemente, como foram observadas porções muito semelhantes entres os indivíduos, optou-se por excluir esses alimentos nas análises. Foram também excluídos do agrupamento alimentos e preparações com baixo consumo, ou seja, aqueles que foram consumidos por menos de 5% da população, como feijoada, yakisoba e risoto. Outro cuidado foi a conversão padronizada de suco em pó (10,8 g de pó para 240 mL de água) a fim de unificar os tipos de sucos e estabelecer uma

única porção para o grupo sucos industrializados. A partir dos 46 grupos de alimentos formados, foi feita uma listagem dos grupos que contribuem com até 90% do valor energético total, utilizando a fórmula de proporção ponderada de Block et al (1986), associada a uma relação dos grupos que foram consumidos por, pelo menos, 10% da população de estudo, a fim de incluir alimentos que não contribuem significativamente com energia, porém, fazem parte da alimentação do paulistano, como as verduras. Assim, a lista para análise das porções totalizou 31 grupos de alimentos (foram excluídos os grupos: vegetais enlatados, achocolatados e bebidas lácteas de outros sabores prontos para beber, derivados de leite exceto queijos, molhos, condimentos, óleos, sal, vinagre, cereais matinais, salgadinhos, pipoca, patês, tortas, oleaginosas).

A falta de consenso em relação à definição de porção de alimentos na literatura é uma importante limitação na comparação entre os estudos. O termo tem sido discutido na comunidade científica internacional, principalmente nas últimas décadas, mas os diferentes significados deixaram dúvidas quanto sua aplicação. Muitas vezes, o tamanho da porção (*“portion size”*) é confundido com a definição de porção sugerida (*“serving size”*). Em 2013, o *“Symposium focusing on advances in scientific understanding of the development of healthy food portion sizes in children and their families”* propôs que o termo porção sugerida (*“serving size”*) se refere à “quantidade listada no rótulo de informação nutricional dos alimentos e nas orientações dietéticas para consumidores” enquanto o termo tamanho da porção (*“portion size”*) refere-se à “quantidade de comida oferecida ou selecionada por consumidores adultos e crianças” (FISHER et al., 2015). Este raciocínio foi aplicado para definição do tamanho da porção utilizada no presente estudo. Assim, o tamanho

da porção foi determinado pela quantidade total consumida (em gramas) do grupo do alimento dividida pelo número de refeições em que o alimento foi consumido por cada indivíduo.

4.5.1.4.2 Consumo energético, densidade energética e razão consumo/necessidade

O consumo energético total foi estimado segundo a metodologia da *Food and Agriculture Organization of the United Nations* (FAO, 2003), que determina coeficientes de conversão de energia mais acurados do que outros métodos, pois leva em consideração a digestão e absorção dos nutrientes. Com base na saída dos macronutrientes do programa NDSR, foram atribuídos os valores de energia para proteínas totais (4 kcal/g), carboidratos disponíveis (4 kcal/g), energia disponível das fibras (2 kcal/g), gorduras totais (9 kcal/g) e álcool (7 kcal/g).

Os valores de densidade energética da dieta (quantidade de energia por grama do alimento) foram obtidos para cada indivíduo dividindo o valor energético total reportado no R24h pela quantidade total de alimentos e bebidas consumida (em gramas) (COX e MELA, 2000).

A razão do consumo energético total pela necessidade energética estimada (VET/NEE) foi utilizada no segundo manuscrito como medida contínua, a fim de ajustar o modelo que investiga a associação do excesso de peso com o tamanho das porções pelo sub- ou super-relato de ingestão energética. Os valores de necessidade energética foram estimados de acordo com as fórmulas do *Institute of Medicine of*

the National Academies, específicas para sexo, idade e estado nutricional (IOM, 2005)

4.5.1.4.3 Estimativa do consumo dietético usual

Para as análises do terceiro manuscrito, a fim de estimar o consumo usual de energia, nutrientes e grupos de alimentos a partir dos dados de dois R24h, foi utilizada a metodologia estatística proposta pelo *National Cancer Institute* (NCI) (TOOZE et al., 2006; TOOZE et al., 2010), que remove a variância intrapessoal inerente ao uso do R24h para este propósito.

A premissa do método é que o consumo usual é igual ao produto da probabilidade de consumo em um determinado dia pela quantidade média consumida em um dia de consumo. Para isso, foram utilizadas as macros MIXTRAN e INDIVINT, versão 2.1, executadas no programa SAS, versão 9.3 (SAS Institute Inc.). Resumidamente, a distribuição usual da ingestão é estimada com base em parâmetros definidos no modelo, como variância intra e interpessoal, λ da transformação Box-Cox e média populacional. A macro MIXTRAN ajusta um modelo de efeitos mistos não-lineares para obter estimativas de parâmetros e permite a avaliação de efeitos de covariáveis, e a macro INDIVINT usa estimativas de parâmetro da MIXTRAN para prever ingestão individual do alimento ou nutriente. As macros e outros detalhes do método do NCI estão disponíveis em: <http://riskfactor.cancer.gov/diet/usualintakes/>.

Apesar de existirem outros métodos para estimar o consumo dietético usual (DODD et al., 2006; SOUVEREIN et al., 2011), o método do NCI foi escolhido devido à possibilidade de incluir na modelagem o peso amostral de ambos os estudos (ISA-Nutrição 2015 e SOL-Youth).

4.5.1.4.4 Índice de Qualidade da Dieta

Para avaliar a qualidade da dieta dos adolescentes do ISA-Nutrição 2015 e do SOL-Youth, foram utilizados dois índices *a priori*, um desenvolvido para a população brasileira (Índice de Qualidade da Dieta Revisado, IQD-R) e o outro, para a população americana (Alternate Healthy Eating Index-2010, AHEI).

O IQD-R, proposto por PREVIDELLI et al. (2011), atualizou o Índice de Qualidade da Dieta (IQD) que se baseava no Healthy Eating Index (HEI) para a população dos EUA (GUENTHER et al., 2007), adaptado e validado para a população brasileira por Fisberg et al. (2004). Foi utilizada a estrutura do IQD, levando em consideração as recomendações nutricionais publicadas no Guia Alimentar para a População Brasileira (2006), possibilitando a avaliação e monitoramento da aderência da dieta dos brasileiros às recomendações nutricionais propostas para os vários estágios da vida. O IQD-R foi validado utilizando a população com 12 anos ou mais de ambos os sexos do ISA-Nutrição 2003 (ANDRADE et al., 2013), e se mostrou confiável e estruturalmente válido para analisar vários componentes da dieta simultaneamente, com base na densidade energética, avaliando sua qualidade, independente da quantidade de alimentos consumida.

O IQD-R apresenta doze componentes, dos quais nove são grupos de alimentos fundamentados no Guia Alimentar para a População Brasileira de 2006, cujas porções diárias são expressas em densidade energética (porção/1.000 kcal) (frutas totais, frutas integrais, vegetais totais, vegetais verde escuros e laranja e leguminosas, cereais totais, cereais integrais, leite e derivados, carne, ovos e leguminosas, óleos); dois são nutrientes (sódio e gordura saturada); e o último representa a soma do valor energético proveniente da ingestão de gordura sólida, álcool e açúcar de adição (gord_AA). Cada componente possui uma pontuação que varia de 0 a 5, 10 ou 20 pontos (Tabela 1). A pontuação máxima do índice é de 100 pontos, sendo que quanto maior a pontuação, melhor a qualidade da dieta.

O número de porções diárias recomendadas dos grupos de alimentos foi definido para cada 1.000 kcal do VET, buscando-se manter a correspondência com o preconizado no Guia para a População Brasileira (2006). Assim, as porções se basearam no valor energético médio por porção:

- Frutas totais: 70 kcal (ex: 1 banana – 86g; 1 maçã – 130g; 1 fatia de abacaxi – 130g; ¾ de copo de requeijão de suco de laranja puro – 187g)
- Vegetais totais: 15 kcal (ex: 15 folhas alface – 120g; 3 fatias de beterraba cozida – 43g; 4 fatias de tomate – 80g; 1 colher de servir de cenoura crua picada – 38g)
- Cereais totais: 150 kcal (ex: 4 colheres de sopa de arroz branco – 125g – ou 6 de arroz integral – 198g; 1 pão francês – 50g; 3,5 colheres de sopa de macarrão cozido – 105g; 1,5 unidade de batata cozida – 202,5g)

- Leite e derivados: 120 kcal (ex: 1 xícara de chá de leite integral – 182g; 3 fatias de queijo mussarela – 45g; 1,5 colher de sopa de requeijão cremoso – 45g)
- Carne, ovos e leguminosas: 190 kcal (ex: 3,5 colheres de sopa de carne moída refogada – 63g; 1 bife grelhado – 64g; 1 concha de feijão cozido 50% caldo – 86g; 2 ovos fritos – 50g)
- Óleos: 73 kcal (ex: 1 colher de sopa de óleo vegetal ou azeite de oliva – 8g; ½ colher de sopa de manteiga – 9,8g; 1 colher de sopa de margarina – 9,8g)

Como os componentes “Fruta Integral”, “Vegetais Verdes Escuros e Alaranjados e Leguminosas” e “Cereais Integrais” não possuem recomendações específicas no Guia de 2006, esses tiveram seus números de porções calculados proporcionalmente aos componentes “Fruta Total”, “Vegetais Totais” e “Cereais, Raízes e Tubérculos”, respectivamente (Tabela 1).

Tabela 1 - Pontuação e porções dos componentes do Índice de Qualidade da Dieta Revisado (IQD-R).

Componentes	Pontuação (pontos)				
	0	5	8	10	20
Frutas totais ^a	0	1,0 p/1000kcal			
Frutas integrais ^b	0	0,5 p/1000kcal			
Vegetais totais ^c	0	1,0 p/1000kcal			
VeVEAI	0	0,5 p/1000kcal			
Cereais totais ^d	0	2,0 p/1000kcal			
Cereais integrais	0	1,0 p/1000kcal			
Leite e derivados ^e	0			1,5 p/1000kcal	
Carnes, ovos e leguminosas	0			1,0 p/1000kcal	
Óleos ^f	0			0,5 p/1000kcal	
Gordura saturada	≥ 15		10	≤ 7% do VET	
Sódio	≥ 2,0		1,0	≤ 0,75 g/1000kcal	
Gord_AA	≥ 35				≤ 10% do VET

Adaptado de: PREVIDELLI et al., 2011

Abreviações: VeVEAI = Vegetais verde-escuros e alaranjados e leguminosas (apenas depois que a pontuação máxima de carnes, ovos e leguminosas for atingida); Gord_AA: calorias provenientes da gordura sólida, álcool e açúcar de adição; VET: valor energético total; p/1000kcal: porção por mil quilocalorias.

^aInclui frutas e sucos de frutas naturais

^bExclui sucos de frutas

^cInclui leguminosas apenas depois que a pontuação máxima de carnes, ovos e leguminosas for atingida

^dCereais totais representa o grupo dos cereais, raízes e tubérculos

^eInclui leite e derivados e bebidas à base de soja

^fInclui as gorduras mono e poli-insaturadas, oleaginosas e gordura de peixe

O AHEI (MCCULLOUGH e WILLETT, 2007) foi desenvolvido como alternativa ao Healthy Eating Index 2005 (HEI-2005) americano, que inclui 12 componentes representantes dos principais grupos de alimentos da Pirâmide Alimentar americana (MyPyramid) e foi elaborado para verificar a adesão ao Guia Alimentar para Americanos de 2005. Diferente do HEI, o AHEI-2010 foi baseado em alimentos e nutrientes com evidências científicas consistentes de associação com risco de doenças crônicas, resultando em maior força de associação com o risco de doenças cardiovasculares e diabetes que o HEI-2005 (CHIUVE et al., 2012). Todos os componentes do AHEI-2010 apresentam pontuação que variam de 0 (pior) a 10

(melhor), e a pontuação total do AHEI-2010 varia de 0 (nenhuma adesão) a 110 (adesão perfeita) (Tabela 2).

Tabela 2 - Pontuação dos componentes do Alternate Healthy Eating Index-2010 (AHEI-2010).

<i>Componente</i>	Critério para pontuação mínima (0)	Critério para pontuação máxima (10)
Vegetais, excluindo batata, porções/d ¹	0	≥ 5
Frutas, excluindo sucos, porções/d ²	0	≥ 4
Grãos integrais, g/d ³	0	
Mulheres		75
Homens		90
Bebidas açucaradas e sucos de frutas, porções/d ⁴	≥ 1	0
Oleaginosas, leguminosas e proteína vegetal, porções/d ⁵	0	≥ 1
Carne vermelha ou processada, porções/d ⁶	≥ 1,5	0
Gordura Trans, % energia	≥ 4	≤ 0,5
Ácidos graxos de cadeia longa (EPA+DHA), mg/d ⁷	0	250
Ácidos graxos poliinsaturados (PUFA), % energia	≤ 2	≥ 10
Sódio, mg/day ⁸	Maior decil	Menor decil
Álcool (doses/dia) ⁹		
Mulheres	≥ 2,5	0,5 – 1,5
Homens	≥ 3,5	0,5 – 2,0

Adaptado de: CHIUVE et al., 2012

¹ Uma porção: 0,5 xícara de legumes ou 1 xícara de hortaliças (1 xícara = 236,59 g).

² Uma porção: uma fruta média ou 0,5 xícara de frutas vermelhas (1 xícara = 236,59 g).

³ Uma porção de um produto 100% integral (ex. 0,5 xícara de aveia ou arroz integral) contém aproximadamente 15-20 g de grãos integrais (por peso seco).

⁴ Uma porção: 8 oz (1 oz = 28,35 g)

⁵ Uma porção: 1 oz (1 oz = 28,35 g) de nozes ou 1 colher de sopa (15 mL) de manteiga de amendoim.

⁶ Uma porção: 4 oz de carne vermelha ou 1,5 oz de carne processada (1 oz = 28,35 g).

⁷ O ponto de corte para a ingestão ideal (250 mg/d) é aproximadamente 2 porções de 4 oz de peixe/semana (1 oz = 28,35 g)

⁸ Os valores no decil mais baixo foram ≤1112 mg/d nas mulheres e ≤1612 mg/d nos homens e no decil mais alto, foram ≥3337 mg/d nas mulheres e ≥5271 mg/d nos homens

⁹ Não consumidores de álcool recebem pontuação de 2,5. Uma porção: 4 oz de vinho, 12 oz de cerveja, ou 1,5 oz de destilado (1 oz = 28,35 g).

O consumo de bebida alcoólica com moderação é pontuado no AHEI-2010, porém, como o índice foi utilizado na presente tese para avaliar a qualidade da dieta de adolescentes, nos quais o consumo de bebida alcoólica não é indicado em nenhuma quantidade, este item foi retirado da pontuação, resultando em um AHEI com pontuação que varia de 0 a 100, na qual 100 indica excelente qualidade da dieta.

4.5.1.5 Dados bioquímicos

Os dados bioquímicos foram obtidos no estudo ISA-Nutrição 2015 por meio da coleta de sangue realizada no domicílio por técnico de enfermagem, instruído a seguir os procedimentos padronizados de coleta de amostras biológicas do estudo. Antes da realização da coleta, a visita era confirmada via telefone e eram dadas orientações sobre o pré-preparo, seguindo um roteiro padronizado, para esclarecimentos quanto à coleta de sangue. As amostras foram coletadas com os indivíduos em jejum de 12 horas para alimentos e bebidas, com exceção de bebidas alcoólicas (mínimo de 36 horas), e sem realizar atividade física ou esforços físicos até que fosse realizado o exame.

Aproximadamente 40 mL de sangue venoso foi coletado de cada indivíduo em tubos secos e com EDTA (ácido etileno-diamino-tetracético), previamente etiquetados, contendo o número de identificação do indivíduo. Os tubos foram acondicionados em caixas de isopor contendo gelo reciclável e transportados ao Laboratório de Nutrição Humana da Faculdade de Saúde Pública da USP para realização de procedimentos específicos para separação de soro, plasma e eritrócitos e alíquotagem. As alíquotas foram armazenadas segundo os requisitos necessários

para cada dosagem – refrigeração ou congelamento. Detalhes dos processos e análises realizadas foram publicados por Fisberg et al. (2018).

No presente estudo, os dados bioquímicos analisados (para o terceiro manuscrito) foram: colesterol total, lipoproteínas de baixa e alta densidade (LDL-c e HDL-c, respectivamente), triglicérides, glicemia de jejum e insulina plasmática. As concentrações séricas de colesterol total foram obtidas por reação de Trinder (colesterol oxidase) (Cobas; Roche Diagnostics GmbH, Mannheim, BW, Germany), as frações LDL-c e HDL-c foram obtidas por ensaio colorimétrico enzimático homogêneo (Cobas; Roche Diagnostics GmbH, Mannheim, BW, Germany) e os triglicérides, por método colorimétrico enzimático (glicerol fosfato peroxidase) (Cobas; Roche Diagnostics GmbH, Mannheim, BW, Germany). A glicemia de jejum plasmática foi obtida por meio do método colorimétrico enzimático com a enzima glicose oxidase (reação de Trinder) (Cobas; Roche Diagnostics GmbH, Mannheim, BW, Germany) e a insulina plasmática por imunoensaio multiplex (LINCOplex®; Linco Research Inc., St. Charles, MO, USA)

O índice HOMA-IR (*Homeostatic Assessment of Insulin Resistance*) foi calculado para indicar resistência à insulina, através da fórmula (MATTHEWS et al., 1985; WALLACE et al., 2004):

$$\frac{\text{Glicemia de jejum plasmática (mg/dL)} \times \text{Insulina de jejum plasmática (\mu\text{U/mL})}{405}$$

Indivíduos com valores de HOMA-IR maiores ou iguais a 2.5 foram considerados com resistência à insulina (MATTHEWS et al., 1985).

4.5.2 Estudo SOL-Youth

A coleta de dados do estudo SOL-Youth ocorreu entre os anos de 2012 e 2014, de forma muito semelhante às coletas dos inquéritos de São Paulo. Os dados socioeconômicos e demográficos e o exame clínico foram obtidos durante uma visita do adolescente, acompanhado pelo responsável, a um dos centros de pesquisa. Os participantes foram instruídos a estar com pelo menos 10 horas de jejum para realização dos exames, vestir roupas leves, e trazer todos os medicamentos que estivessem sendo tomados na época da pesquisa. Os questionários aplicados poderiam ser respondidos em inglês ou espanhol, de acordo com a preferência do participante.

Dentre os diversos exames clínicos realizados, estavam incluídos: antropometria (peso aferido com balança digital Tanita Body Composition Analyzer TBF-300A; Tanita Corporation, Japão; estatura aferida com estadiômetro de parede; Seca 222, Seca GmbH & Co, Alemanha; e circunferência de cintura aferida com fita antropométrica Gulick; Creative Engineering, Plymouth, Michigan), pressão arterial com o indivíduo sentado com descanso de pelo menos cinco minutos (esfigmomanômetro OMRON HEM-907XL, OMROM Corporation, Japão), além de amostras de sangue, que foram coletadas, conforme procedimento padrão, para a avaliação de diversos analitos, como: colesterol total (método enzimático colesterol oxidase, Roche Diagnostics, Indianapolis, Indiana), HDL-c (método direto magnésio/dextrano sulfato), LDL-c (equação Friedewald), triglicérides (método de enzima de supressão de glicerol, Roche Diagnostics), glicemia de jejum plasmática

(método enzimático hexoquinase, Roche Diagnostics), insulina em jejum, hemoglobina glicada (Tosoh G7 Automated HPLC Analyzer (Tosoh Bioscience Inc, South San Francisco, California), entre outros.

Assim como no ISA-Nutrição 2015, o método de inquérito utilizado para avaliar o consumo alimentar foi a aplicação de dois R24h, sendo que o primeiro foi realizado pessoalmente e o segundo, por telefone. O procedimento de aplicação dos R24h também seguiu o *Multiple Pass Method*, representando todos os dias da semana e estações do ano, e os dados de consumo foram inseridos no programa NDSR (*Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, EUA*). Um banco de dados com alimentos de origem tipicamente hispânicas foi elaborado com uma variedade de receitas e formulações de alimentos, a fim de complementar os dados disponíveis no NDSR. Mais detalhes do estudo foram publicados por ISASI et al. (2014).

4.5.3 Classificação de fatores de risco cardiometabólico

A variável número de fatores de risco para doença cardiovascular foi categorizada como tendo três ou mais das seguintes condições: obesidade [de acordo com os pontos de corte da *World Obesity Federation* (COLE et al., 2000)], pressão arterial sistólica ou diastólica alta ($\geq$ percentil 90 para sexo, idade e altura) (NATIONAL HIGH BLOOD PRESSURE EDUCATION PROGRAM, 2004), dislipidemia (colesterol total $\geq$ 200 mg / dL, ou LDL-c $\geq$ 130 mg / dL, ou HDL-c $\leq$ 40 mg / dl, ou triglicérides $\geq$ 150 mg / dL) (EXPERT PANEL, 2011), glicemia de jejum elevada ($\geq$ 100 mg / dL) ou hemoglobina glicada A1c ($\geq$ 5,7 mg / dL), ou

resistência à insulina ($\text{HOMA-IR} \geq 2,5$) (ADA, 2015). Os adolescentes foram caracterizados com síndrome metabólica segundo dois parâmetros distintos, devido à falta de consenso na literatura:

- Definição modificada para crianças e adolescentes, com base nas diretrizes do *Adult Treatment Panel III* (ATP III) do *National Cholesterol Education Programme* (NCEP) para adultos (GRUNDY et al., 2004). O adolescente é considerado com síndrome metabólica quando três ou mais dos seguintes fatores estão presentes: pressão arterial (sistólica ou diastólica) elevada, aumento dos triglicérides, HDL-c baixo, glicemia de jejum elevada, presença de diabetes tipo 2, adiposidade central (STEINBERGER et al., 2009).

- Definição da *International Diabetes Federation* (IDF), em que o adolescente é considerado com síndrome metabólica quando apresenta obesidade central (obrigatoriamente) e a presença de duas ou mais outras características clínicas (aumento dos triglicérides, HDL-c baixo, pressão arterial sistólica ou diastólica elevada, glicemia de jejum elevada) (ALBERTI et al., 2006)

4.5.4 Variáveis do estudo

Diversas variáveis foram utilizadas no presente estudo a fim de investigar cada um dos objetivos. A descrição da classificação de cada uma delas está detalhada no **Quadro 3**, segundo o manuscrito em que foram apresentadas. As referências utilizadas para determinar os pontos de corte estão descritas no item 4.5 Coleta e processamento de dados.

Quadro 3: Relação das variáveis de estudo por manuscrito.

	Variável	Descrição
MANUSCRITO 1	Sexo	- Masculino - Feminino
	Faixa etária	- Adolescentes (12 a 19 anos) - Adultos (20 a 59 anos) - Idosos (60 anos ou mais)
	Raça / cor da pele	- Branca - Não branca (preta, parda, amarela, indígena, outros)
	Situação Conjugal	- Casado / união estável - Solteiro - Separado / Divorciado - Viúvo(a)
	Situação de trabalho	- Trabalhando - Desempregado - Estudante - Outros (aposentado, dono/a de casa, etc.)
	Renda familiar per capita	$\leq$ 1 salário mínimo $>$ 1 salário mínimo
	Escolaridade do chefe de família	- Menos que o ensino médio - Ensino médio ou mais
	Hábito atual de fumar	- Não fumante - Ex-fumante - Fumante atual
	Consumo de bebida alcoólica	- Nunca $\leq$ 3 vezes por semana $\geq$ 4 vezes por semana
	Atividade física global	- Atinge a recomendação da OMS ^a - Não atinge a recomendação da OMS ^a
	Estado nutricional	- Sem excesso de peso - Sobrepeso ^b - Obesidade ^c
	Ano do ISA-Capital	- 2003 - 2008 - 2015

^a Recomendação da OMS: $\geq$ 420 min/semana, incluindo 60 min/dia para adolescentes e $\geq$ 150 min/semana para adultos e idosos

^b Adolescentes: $+1DP < IMC\text{-para-idade} \leq +2DP$. Adultos: $25 \leq IMC < 30 \text{ kg/m}^2$. Idosos: $28 \leq IMC < 30 \text{ kg/m}^2$

^c Adolescentes $IMC\text{-para-idade} > +2DP$. Adultos e idosos: $IMC \geq 30 \text{ kg/m}^2$

	Variável	Descrição
MANUSCRITO 2	Sexo	- Masculino - Feminino
	Faixa etária	- Adolescentes (12 a 19 anos) - Adultos (20 a 59 anos) - Idosos (60 anos ou mais)
	Idade	Anos
	Estado nutricional	- Sem excesso de peso - Com excesso de peso (sobrepeso e obesidade) ^d
	Raça / cor da pele	- Branca - Não branca (preta, parda, amarela, indígena, outros)
	Renda familiar per capita	≤ 1 salário mínimo > 1 salário mínimo
	Escolaridade do chefe de família	- Menos que o ensino médio - Ensino médio ou mais
	Hábito atual de fumar	- Não fumante - Ex-fumante - Fumante atual
	Consumo de bebida alcoólica	- Nunca ≤ 3 vezes por semana ≥ 4 vezes por semana
	Atividade física global	- Atinge a recomendação da OMS ^a - Não atinge a recomendação da OMS ^a
	Atividade física no lazer	- Atinge a recomendação da OMS ^a - Não atinge a recomendação da OMS ^a
	Consumo energético total	kcal/dia
	Consumo/Necessidade energética	Razão consumo kcal/necessidade kcal
	Gramas totais	gramas/dia
	Densidade energética total	kcal/g
	Proteínas totais	% kcal
	Carboidratos totais	% kcal
	Gorduras totais	% kcal
	Porções dos grupos de alimentos	gramas e % de consumo
	Dia da semana	- Dia de semana - Final de semana (sábado e domingo)
	Intenção de perder peso	- Sim - Não
	Refeições	- Número de refeições por dia
	Ano do ISA-Capital	- 2003 - 2008 - 2015

^aRecomendação da OMS: ≥ 420 min/semana, incluindo 60 min/dia para adolescentes e ≥150 min/semana para adultos e idosos

^dAdolescentes: IMC-para-idade > + 1DP. Adultos: IMC ≥25 kg/m². Idosos: IMC ≥28 kg/m²

	Variável	Descrição
MANUSCRITO 3	Sexo	- Masculino - Feminino
	Faixa etária	- 12 a 13,9 anos - 14 a 16 anos
	Estado nutricional	- Sem excesso de peso - Com excesso de peso (sobrepeso e obesidade ^e)
	Origem latina (apenas SOL-Youth)	- Dominicano - Porto-riquenho - Cubano - América Central - Mexicano / Mexicano Americano - Sul Americano - Hispânico Misto - Outros
	Escolaridade do chefe de família	- Menos que o ensino médio - Ensino médio ou equivalente - Maior que ensino médio
	Renda familiar anual total	≤ US\$ 15000 > US\$ 15000
	Renda familiar per capita	- 1º tercil - 2º tercil - 3º tercil
	Situação Conjugal do responsável	- Casado / união estável - Solteiro - Separado / Divorciado / Viúvo(a)
	Adiposidade central	- Sim (≥ p 90) - Não (< p 90)
	Pressão arterial sistólica	< p 90 ≥ p 90
	Pressão arterial diastólica	< p 90 ≥ p 90
	Hipertensão	- Pré-hipertenso p90 – p94 - Hipertenso ≥ p 95
	Colesterol total	< 200 mg/dL ≥ 200 mg/dL
	HDL-c	< 40 mg/dL ≤ 40 mg/dL
	LDL-c	< 130 mg/dL ≥ 130 mg/dL
	Triglicérides	< 150 mg/dL ≥ 150 mg/dL

Abreviações: HDL-c, Lipoproteína de alta densidade; LDL-c, Lipoproteína de baixa densidade; p, percentil.

^eDe acordo com os pontos de corte da *World Obesity Federation* (COLE et al., 2000)

MANUSCRITO 3	Razão TG/HDL-c	< 2,2 ≥ 2,2
	Dislipidemia	- Sim - Não
	Glicemia de jejum	<100 > 100 > 126
	Glicemia de jejum comprometida	- Sim (uso de hipoglicemiante, diabetes tipo 2 autorreferida, ou glicemia > 100) - Não
	Resistência à insulina	- Sim (HOMA ≥ 2.5) - Não (HOMA < 2.5)
	Fatores de risco cardiometabólico	< 3 dos fatores anteriores ≥ 3 dos fatores anteriores
	Síndrome metabólica	- Sim - Não
	Energia	kcal/dia
	Gramas totais	gramas de alimentos e bebidas
	Densidade de energia	kcal/gramas
	Proteínas totais	gramas/dia e % kcal
	Carboidratos totais	gramas/dia e % kcal
	Gorduras totais	gramas/dia e % kcal
	AG saturados	% kcal
	AG <i>trans</i>	% kcal
	AG poliinsaturados	% kcal
	AG de cadeia longa (EPA+DHA)	gramas/dia
	Fibras totais	gramas/dia
	Açúcar total	% kcal
	Açúcar de adição	% kcal
	Colesterol	mg/dia
	Sódio	mg/dia
	Cálcio	mg/dia
	Fósforo	mg/dia
	Ferro	mg/dia
	Zinco	mg/dia
	Potássio	mg/dia
	Vitamina A (RAE)	mcg/dia
	Vitamina D	mcg/dia
	Vitamina C	mg/dia
	AHEI-2010	Pontuação total e componentes
	IQD-R	Pontuação total e componentes

Abreviações: HDL-c, Lipoproteína de alta densidade; TG, Triglicérides; AG, Ácidos graxos; HOMA, Homeostatic Assessment of Insulin Resistance.

4.6 ANÁLISE ESTATÍSTICA

Na presente tese, variáveis categóricas foram descritas por sua frequência e intervalo de confiança de 95% e diferenças foram observadas por meio do teste chi-quadrado de Pearson e pela não sobreposição dos intervalos de confiança. As variáveis contínuas foram descritas por sua média, mediana e erro-padrão ou intervalo interquartil, e diferenças foram observadas por meio de testes de Mann-Whitney para variáveis não paramétricas contínuas. Modelos de regressão logística múltipla foram utilizados para verificar associações entre as variáveis, com a variável dependente dicotômica, ajustando por variáveis de confusão.

As análises foram realizadas nos programas Stata, versão 12. (StataCorp, Texas, USA) e SAS, versão 9.3 (SAS Institute, Cary, NC), considerando o desenho amostral e os respectivos pesos para representatividade populacional (modo *survey*). O nível de significância considerado foi de 5%. Detalhes das análises estatísticas realizadas estão descritos em cada um dos manuscritos.

4.7 ASPECTOS ÉTICOS

O presente estudo foi aprovado pelo Comitê de Ética em Pesquisa da Faculdade de Saúde Pública da universidade de São Paulo (CAAE nº 56958916.5.0000.5421) e cada um dos estudos utilizados teve aprovação dos respectivos comitês de ética. A participação dos indivíduos foi voluntária, após assinatura do termo de assentimento ou consentimento livre e esclarecido.

4.8 FINANCIAMENTO

O presente trabalho obteve financiamento da Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, processos 2016/07711-8 e 2017/02480-0).

5 RESULTADOS E DISCUSSÃO

Os resultados e discussão desta tese estão apresentados no formato de três manuscritos:

- **Manuscrito 1:** “*Excess body weight in the city of São Paulo: panorama from 2003 to 2015, associated factors and projection for the next years*”, em revisão no periódico *BMC Public Health* (fator de impacto de 5 anos: 3.039; Estrato A1 na área de concentração Saúde Coletiva – Qualis Capes).

- **Manuscrito 2:** “*Differences over 12 Years in Food Portion Size and Association with Excess Body Weight in the City of São Paulo, Brazil*”, publicado em 30/05/2018 no periódico *Nutrients* [fator de impacto de 5 anos: 4.603 (2017); Estrato A1 na área de concentração Saúde Coletiva – Qualis Capes].

- **Manuscrito 3:** “*Diet quality, excess body weight, and cardiometabolic risk factors in adolescents living in São Paulo, Brazil and in the USA – differences and similarities*”, cuja submissão será realizada após avaliação e aprovação da tese pela banca examinadora.

5.1 PRIMEIRO MANUSCRITO

Excess body weight in the city of São Paulo: panorama from 2003 to 2015, associated factors and projection for the next years

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Keywords: overweight, obesity, survey, population, São Paulo, Brazil

5.1.1 Abstract

Background: Excess body weight (EBW: overweight and obesity) has high and rising prevalence in Brazil. Up-to-date information about the distribution and changes in the prevalence of EBW and their associated factors are essential to determine target groups and to identify priority actions. The aim of this study was to investigate the associated factors and to determine the prevalence of overweight and obesity in the adolescent and adult population of the city of São Paulo in the years of 2003, 2008, and 2015, as well as to estimate the prediction for the next years.

Methods: Individuals aged 12 years and older from three editions of the Health Survey of São Paulo (ISA-Capital), a cross-sectional population-based survey, carried out in 2003 (n= 2,144), 2008 (n=2,599), and 2015 (n=3,939), had their socioeconomic, anthropometric, and lifestyle data collected at households. Individuals were classified according to their age and BMI as: without overweight, overweight, or obese. Differences were evaluated through Pearson's Chi-square test and comparison of 95% CI. Generalized ordered logit models were used to evaluate factors associated to overweight/obesity and logistic regression models were used to predict their prevalence for the next years.

Results: The prevalence (95% CI) of obesity in total population doubled: from 10% (8.0, 12.5) in 2003 to 19.2% (17.8, 20.6) in 2015. The main increase occurred in female adolescents from 2.5% (1.2, 5.3) to 11.2% (8.4, 14.7) and adults, from 9.2% (6.4, 13.1) to 22.3% (20.0, 24.8). Those with higher chance of having EBW were adults, those with higher income, and former smokers. The prevalence of EBW increased 31% from 2003 to 2008, and 126% from 2003 to 2015, when half of the population had EBW. If this pattern does not change, 77% of the population is expected to have EBW by 2030.

Conclusions: Our findings present up-to-date information about the distribution of EBW, which increased substantially over a short time and more prominently in specific groups. The factors associated with EBW may provide important information for decision makers and researchers to create or review the existing programs and interventions in order to decrease the trend for the next years.

Keywords: overweight, obesity, survey, population, São Paulo, Brazil.

5.1.2 Background

In the last decades, excess body weight, including overweight and obesity, has gained importance worldwide because of the high and rising prevalence in many countries, with variations in the levels and trends according to specific regional patterns [1]. Worldwide, the prevalence of excess body weight between 1980 and 2013 rose by 27.5% for adults and 47.1% for children [1]. In 2016, excess body weight was present in 340 million children and adolescents aged 5-19 and in more than 1.9 billion adults (39%); of these over 650 million (13%) were obese [2]. More than 50% of adult population of men in Tonga and of women in Kuwait, Kiribati, Federated States of Micronesia, Libya, Qatar, Tonga, and Samoa are obese. Regardless of developed countries have attenuated the increase in obesity in the last decade, many of them still have a very high prevalence, and it is continually increasing in developing countries, where almost two in three obese people in the world live [1].

This is a public health concern because overweight and obesity are important risk factors for other diseases with high morbidity and mortality rates, such as diabetes, some types of cancer, cardiovascular, respiratory and musculoskeletal diseases [3]. A systematic evaluation of the health effects of high body mass index (BMI) estimated that excess body weight accounted for about 4 million deaths and 120 million disability-adjusted life-years worldwide in 2015 [4]. Thus, besides individual health problems, excess body weight also causes a significant increase in direct and indirect health costs, becoming a problem for the economy and the health systems [5-7]. A study with the 2008–2009 Brazilian Household Budget Survey estimated that the presence of an obese individual in the household was associated

with 19 % higher monthly expenses on medicines per capita compared to households without an obese resident [6]. The estimated direct costs associated to patient care in one year in the Brazilian Health System (SUS) with all diseases related to excess body weight exceed US\$ 2.1 billion, and approximately 10% of this value is attributable exclusively to overweight and obesity [7].

Up-to-date information about the distribution, magnitude and changes in the prevalence of excess body weight across the years as well as their associated factors are essential to help decision makers and researchers to determine target groups and to identify priority actions for interventions to decrease excess body weight in the population [1, 8]. In this context, studies have reported associations between excess body weight and factors such as age, gender, socioeconomic status, physical activity, tobacco and alcohol intake, diet quality and several others, that may differ in the strength and direction of this relationship according to each population [1, 9-14].

Nationally representative survey data show that the prevalence of excess body weight in Brazil has steadily increased over the past four decades, with disparities between population groups [15, 16]. According to the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey, VIGITEL [17], more than half of the population has excess body weight, wherein one in every five Brazilians is obese. This national survey indicates that in São Paulo, which is the biggest city in Brazil and one of the most populous cities in the world, with more than 12 million habitants [18], the outlook is similar to the country: 54% of adults have excess body weight and 18% are obese [17]. Although VIGITEL monitors the frequency and distribution of the main determinants of chronic noncommunicable

diseases (NCD), such as smoking status, alcohol intake, and physical activity in the 26 State capitals and Federal District, the survey does not explore the direct association of these factors with the body weight status. Also, because it is a survey design to get the information by telephone interviews, it only allows inference for the population who lives in households with landline telephone. In addition, the survey sample includes people aged 18 years and older. In Brazil, 17% of adolescents are overweight and 8% are obese, and this is an important age group, especially regarding opportunities for prevention of excess body weight related diseases in future life [19, 20].

In this context, the Health Survey of São Paulo (*Inquérito de Saúde de São Paulo*, ISA-Capital) is a cross-sectional population-based survey, conducted periodically to evaluate the health status and the use of health services of a probabilistic sample of individuals aged 12 years and older living in the city of São Paulo [21]. With face-to-face interviews carried out in the households, the ISA-Capital provides detailed information regarding socioeconomic and lifestyle characteristics, which allows a current overview of the health in the city. The prevalence of excess body weight in the city was previously published in the Municipal Government Report [22], however the associated factors were not investigated. Therefore, the aim of this study is to determine the changes on overweight and obesity prevalence in the adolescent and adult population of the city of São Paulo in the years of 2003, 2008, and 2015, to investigate the associated factors as well as to estimate the prediction for the next years. The concept underlying our hypothesis is that the sociodemographic factors evaluated in this survey will be associated to excess body weight in this population.

5.1.3 Methods

Population and study design

The present paper analyses data from three editions of the Health Survey of São Paulo (ISA-Capital), a cross-sectional population-based survey that aimed to evaluate the health status and the use of health services in a representative sample of residents of the city of São Paulo, Southeastern Brazil. The surveys were carried out in three years: 2003 (n= 3,357), 2008 (n=3,271), and 2015 (n=4,043) and employed a similar sampling process. They used a complex sampling design with a two-stage cluster: census tracts and households. Details of the studies and their sampling design are published elsewhere [23, 24]. The surveys were approved by Ethics Committee on Research of the School of Public Health, University of São Paulo. Written informed consent/assent was obtained before commencement of the study from all subjects and, when adolescent, also from their proxies.

For the present study, inclusion criteria were individuals aged at least 12 years old, with complete anthropometric, age and sex information. We analyzed a total of 2,144 individuals (711 adolescents from 12 to 19 years old, 711 adults from 20 to 59 years old, and 722 older adults aged 60 years or more) for the 2003 ISA-Capital; a total of 2,599 individuals (569 adolescents, 1,141 adults, and 889 older adults) for the 2008 ISA-Capital; and a total of 3,939 individuals (822 adolescents, 2,126 adults, and 991 older adults) for the 2015 ISA-Capital.

Data collection

Trained interviewers used a structured questionnaire administered at households to collect individuals demographic (sex, age, race/skin color, marital status) and socioeconomic data (family income, educational level, working status), as well as lifestyle information (smoking status, alcohol consumption, and physical activity).

Total household income was assessed adding all the net income (individual's income after taking taxes and deductions into account) of each individual in the household, including wages, retirement, government benefits, pension, grants, rental income, and any other. The total amount was divided by the number of persons in the household in order to estimate the per capita household income. For analysis purposes, this variable was categorized as ≤ 1 minimum wage or > 1 minimum wage, in order to enable the comparison across the survey years. One minimum wage is approximately 78 US dollars in 2003, 217 US dollars in 2008, and 236 US dollars in 2015.

Questions about smoking habits, tobacco use and number and frequency of cigarettes per day were performed in order to define smoking status. Those who referred currently smoke at least one cigarette per day, every day, for at least one month, were considered smokers. Those who referred not currently smoke, but have already smoked at least one cigarette per day, every day, for at least one month in the past were considered former-smokers [25].

Alcohol intake was evaluated in ISA-Capital 2003 and 2008 using the “*Cut Down, Annoyed by Criticism, Guilty and Eyeopener*” (CAGE) [26] and in ISA-

Capital 2015, using the “*Alcohol Use Disorders Identification Test*” (AUDIT) [27], associated to complementary questions. We used the frequency of alcohol consumption: never, ≤ 3 times per week, or ≥ 4 times per week, in order to enable the comparison across the individuals from the three surveys.

Physical activity was assessed using the long International Physical Activity Questionnaire, validated for Brazilian population [28]. Individuals were classified as ‘meet the recommendation’ or ‘do not meet the recommendation’ according to the latest recommendations for global physical activity of World Health Organization for each life stage: ≥ 420 min/week, including 60 min/day for adolescents; ≥ 150 min/week for adults and older adults [29].

Anthropometric Measurements

Height and weight, used to calculate the body mass index (BMI= weight (kg) / squared height (m^2)), were self-reported. The use of self-reported high and weight is known to incur in possible errors, but previous study with the same population showed good agreement between measured and self-report weight, height and BMI [30].

Individuals were classified according to their age and BMI into three groups: without overweight, overweight, or obese. Adolescents were classified according to the World Health Organization curves for children and adolescents [31], in which they were considered overweight when BMI-for-age was $>+1\text{SD}$ and $\leq +2\text{SD}$ (equivalent to BMI 25 kg/m^2 at 19 years) and obese when BMI-for-age $>+2\text{SD}$ (equivalent to BMI 30 kg/m^2 at 19 years). Adults were considered overweight when $25 \leq \text{BMI} < 30 \text{ kg}/\text{m}^2$ and obese when $\text{BMI} \geq 30 \text{ kg}/\text{m}^2$ [8]. Older adults were

classified with overweight ($28 < \text{BMI} < 30 \text{ kg/m}^2$) or obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$) according to the cut-off points recommended by the Pan American Health Organization (OPAS) in the Health, Well-Being, and Aging Study (SABE) with Latin American countries, including Brazil [32]. We used the term excess body weight when referring to overweight and obesity combined.

Statistical Analysis

Stata software was used in all analysis (Statistics/Data Analysis, version 13.1, Texas, USA), considering the complex sampling design (*svy* commands). All statistical tests considered the significance level of 5%. Differences in the prevalence of socioeconomic and demographic variables according to ISA-Capital year after running proportion on estimation were evaluated through Pearson's Chi-square test with the Rao and Scott second-order correction and comparison of the 95% confidence interval (CI).

Generalized ordered logit models for ordinal dependent variables were used to evaluate the factors associated to overweight/obesity (without overweight = 0, overweight = 1, obese = 2) [33, 34]. The following variables were statistically significant ($p < 0.20$) in the univariate analysis and were included in the models: sex (male or female), age group (adolescents, adults, or older adults), self-reported race (white or non-white), marital status (married/with partner, single, separated/divorced, or widow(er)), working status (working, not working, student only, other), per capita family income (more or less than one minimum wage), education of householder (more or less than high school), smoking status (non-smoker, former smoker, or current smoker), alcohol consumption (never, ≤ 3 times per week, or ≥ 4 times per

week), physical activity level (meet or do not meet the WHO recommendations), and ISA-Capital year (2003, 2008, or 2015). Wald tests were used to test the proportional odds assumption in the model. The final multiple model did not present any negative predicted probabilities and the values of Basic Information Criterion (BIC) and Akaike's Information Criterion (AIC) were compared in order to choose the more parsimonious and adequate model. The factors were considered associated to overweight or obesity when $p\text{-value} < 0.05$.

In order to predict the prevalence of overweight and obesity for the next years, we used logistic regression models [35] with the same variables of the ordered logit models, except marital status (due to the low number of individuals in some categories across the age groups). We conducted two models for each age group: a) without overweight = 0, excess body weight = 1; and b) without overweight and overweight = 0, obese = 1. The coefficients of the models were used to calculate the prevalence for each age group: $\text{Prob}(y=1) = 1 / 1 + \exp(-(\beta_0 + \beta_1 * \text{year}))$.

5.1.4 Results

The number of adolescents in the population decreased from 2003 to 2015, as well as the proportion of people who declare themselves white, single, families whose householder did not complete high school, and those with higher income. In contrast, there was an increase in the proportion of older adults, non-smokers, people working, and who do not consume alcoholic beverages (Table 1, total population). The prevalence of obesity doubled in the period. In 2015, considering all age groups, 21% of female and 17% of male were obese. The prevalence of overweight and obesity for total population was 26 % and 10 % in 2003, 29 % and 13 % in 2008, and

30 % and 19 % in 2015, respectively. During this time period, the prevalence of both overweight and obesity increased in men, in those who declared themselves non-white, single, working, with lower income and education, and non-consumers of alcohol. Obesity rates increased in adolescents and adults, in women, in those who declared themselves white, married, not working, with higher income and education, non- and former smokers, moderate consumers of alcohol, and in both physical activity levels (Table 1).

Figure 1 presents the prevalence of overweight and obesity in the population of São Paulo according to age group in 2003, 2008 and 2015, with differences in the prevalence being compared according to the lack of overlap of the 95% confidence intervals. Obesity increased in adolescents from 3.7% in 2003 to 9.3% in 2015 (in girls the prevalence increased from 2.5% to 11.2%) and it doubled in adults in this period (in women it was 9.2% in 2003 and 22.3% in 2015). Despite an apparent increase in the prevalence of overweight in adults and obesity in older adults, the difference was not significant. In 2015, the prevalence of overweight according to gender was similar in adolescents (19%) and older adults (13%), but it was higher in men (41.6%) than in women (31.3%) in adult population (20-59 years old).

Table 1: Characteristics of subjects in the Health Survey of São Paulo (ISA-Capital) 2003, 2008, and 2015, for total population and for overweight and obesity (n=8,682).

		ISA-Capital 2003 (n=2144)							ISA-Capital 2008 (n=2599)						
		Total population		Overweight		Obese		p ^a	Total population		Overweight		Obese		p ^a
		%	95%CI	%	95%CI	%	95%CI		%	95%CI	%	95%CI	%	95%CI	
<i>Age group</i>															
Adolescents (12 - 19 yrs)		17.9	16.1, 19.8	16.2	12.6, 20.6	3.7	2.3, 5.9		14.7	12.9, 16.7	19.5	16.1, 23.3	5.9	4.1, 8.5	
Adults (20 - 59 yrs)		69.7	67.7, 71.6	30.9	27.1, 35.0	10.6	8.1, 13.9		71.6	69.0, 74.0	34.4	31.5, 37.4	13.2	11.2, 15.5	
Older adults (≥60 yrs)		12.5	10.9, 14.2	11.5	9.2, 14.2	15.7	12.5, 19.6	<0.0001	13.7	11.8, 16.0	13.7	11.7, 16.0	19.1	16.0, 22.5	<0.0001
<i>Sex</i>															
Male		47.7	45.0, 50.5	27.3	23.4, 31.7	11.0	8.3, 14.4		47.2	45.2, 49.2	33.6	30.1, 37.3	12.2	9.8, 15.1	
Female		52.3	49.5, 55.0	24.5	20.6, 28.9	9.2	7.0, 11.9	0.2602	52.8	50.8, 54.8	25.6	23.2, 28.0	13.6	11.6, 15.8	0.0012
<i>Race/Skin color</i>															
White		67.2	63.2, 70.9	27.3	24.0, 31.0	10.7	8.1, 14.1		62.0	56.9, 66.8	30.2	27.5, 33.0	13.2	11.2, 15.6	
Non-white		32.8	29.1, 36.8	22.7	18.8, 27.2	8.7	6.4, 11.9	0.0832	38.0	33.2, 43.1	27.8	24.3, 31.6	12.4	10.5, 14.7	0.3851
<i>Marital status</i>															
Married / partners		39.1	35.5, 42.9	31.7	24.8, 39.6	10.9	7.2, 16.1		42.7	39.8, 45.6	33.5	29.6, 37.6	15.1	12.0, 18.8	
Single		56.8	53.1, 60.5	17.1	13.7, 21.2	5.3	2.9, 9.6		51.7	48.6, 54.7	19.6	16.6, 23.0	6.6	4.8, 8.8	
Separated / Divorced		1.9	1.2, 3.1	28.6	10.6, 57.5	8.4	1.5, 34.9		3.5	2.6, 4.7	17.3	8.4, 32.4	13.4	6.1, 27.0	
Widow(er)		2.2	1.6, 3.0	7.3	3.3, 15.6	13.5	5.3, 30.2	<0.0001	2.2	1.6, 2.9	8.4	3.6, 18.2	19.5	10.5, 33.2	<0.0001
<i>Working status</i>															
Working		45.1	40.6, 49.8	21.6	17.0, 27.0	8.5	5.8, 12.3		53.4	49.7, 57.1	29.6	25.6, 33.9	9.1	6.6, 12.3	
Not working		29.5	26.4, 32.8	30.1	21.7, 40.0	9.7	5.6, 16.3		26.7	21.7, 27.9	21.2	16.8, 26.2	17.4	13.4, 22.3	
Student only		22.6	19.4, 26.1	17.7	13.7, 22.7	5.2	2.2, 11.6		20.8	17.9, 24.0	19.8	15.7, 24.6	7.1	4.3, 11.4	
Other		2.9	1.9, 4.4	10.8	3.9, 26.5	0.0	-	0.0197	1.1	0.7, 1.9	5.1	1.1, 19.8	10.5	2.9, 31.4	<0.0001
<i>Per capita family income</i>															
≤ 1 minimum wage		35.1	30.8, 39.7	22.1	18.3, 26.4	7.8	5.5, 10.8		36.4	31.2, 41.9	25.5	22.1, 29.3	12.6	10.3, 15.3	

> 1 minimum wage	64.9	60.3, 69.3	27.2	23.4, 31.3	11.0	8.2, 14.7	0.0339	63.7	58.1, 68.9	31.7	28.9, 34.6	13.1	11.0, 15.6	0.0213
<i>Education of householder</i>														
Less than High School	54.0	49.3, 58.6	23.7	20.5, 27.3	10.3	8.0, 13.2		43.6	37.1, 50.4	26.6	23.6, 30.0	13.5	11.5, 15.9	
High School or higher	46.0	41.5, 50.7	28.2	23.9, 32.9	9.6	6.6, 13.8	0.2958	56.4	49.6, 62.9	31.7	28.8, 34.8	12.3	9.8, 15.2	0.0963
<i>Smoking status</i>														
Non-smoker	65.5	62.7, 68.2	25.1	21.7, 28.9	9.9	7.7, 12.6		64.3	61.5, 67.1	28.4	25.4, 31.5	11.4	9.6, 13.4	
Former smoker	15.2	12.8, 18.0	35.7	28.8, 43.2	13.5	8.8, 20.3		16.4	14.4, 18.7	33.5	29.0, 38.4	21.3	17.3, 25.8	
Current smoker	19.3	16.8, 22.0	20.4	15.1, 27.0	8.2	4.5, 14.3	0.0037	19.2	16.9, 21.9	29.1	24.6, 34.1	10.9	7.6, 15.5	<0.0001
<i>Alcohol intake</i>														
Never	46.2	42.6, 49.8	22.4	19.2, 25.9	11.2	8.8, 14.1		43.6	40.8, 46.4	25.9	22.8, 29.1	12.7	10.4, 15.3	
≤ 3 times per week	48.4	44.8, 51.9	28.1	24.0, 32.5	9.2	6.6, 12.7		51.0	48.3, 53.7	32.4	29.4, 35.7	13.0	10.7, 15.9	
≥ 4 times per week	5.5	4.2, 7.1	36.2	25.4, 48.7	9.4	4.2, 19.5	0.0460	5.5	4.4, 6.8	29.8	22.3, 38.6	13.2	8.2, 20.8	0.0427
<i>Physical activity level</i>														
Do not meet	22.8	19.9, 26.1	24.2	19.4, 29.7	11.6	8.3, 16.0		19.3	17.1, 21.8	22.9	18.5, 27.8	13.1	9.8, 17.2	
Meet the recommendations	77.2	73.9, 80.1	26.2	23.0, 29.6	9.6	7.5, 12.2	0.5079	80.7	78.2, 82.9	30.9	28.5, 33.4	12.9	11.0, 15.0	0.0224
<i>Body weight status</i>														
Overweight	25.9	23.1, 28.8	-	-	-	-		29.4	27.3, 31.6	-	-	-	-	
Obesity	10.0	8.0, 12.5	-	-	-	-		12.9	11.3, 14.7	-	-	-	-	

^a Pearson's Chi-square test with the Rao and Scott second-order correction p-values for differences in the prevalence of overweight and obesity in each ISA-Capital survey (each variable vs. BMI categories in each ISA-Capital survey).

^b Pearson's Chi-square test with the Rao and Scott second-order correction p-values for differences in total population prevalence for each variable across ISA-Capital surveys (prevalence of each variable vs. year of each ISA-Capital survey).

^c Pearson's Chi-square test with the Rao and Scott second-order correction p-values for differences in the prevalence of overweight and obesity in the ISA-Capital (aggregate data from ISA-Capital 2003, 2008 and 2015 of each variable vs. BMI categories).

	ISA-Capital 2015 (n=3939)								
	Total population		Overweight		Obese				
	%	95%CI	%	95%CI	%	95%CI	p ^a	p ^b	p ^c
Age group									
Adolescents (12 - 19 yrs)	13.2	12.0, 14.4	19.5	16.9, 22.4	9.3	7.6, 11.4			
Adults (20 - 59 yrs)	70.8	69.1, 72.5	36.2	34.0, 38.4	20.5	18.7, 22.5			
Older adults (≥60 yrs)	16.0	14.3, 17.9	13.2	10.9, 15.9	21.2	18.7, 24.0	<0.0001	0.0008	<0.0001
Sex									
Male	47.0	45.4, 48.6	34.4	31.8, 37.1	17.1	14.9, 19.5			
Female	53.0	51.4, 54.6	26.7	24.4, 29.1	21.0	19.2, 23.0	<0.0001	0.8798	<0.0001
Race/Skin color									
White	51.4	48.0, 54.8	30.4	27.8, 33.1	19.6	17.5, 21.9			
Non-white	48.6	45.2, 52.0	30.0	27.9, 32.2	18.9	17.2, 20.7	0.8032	<0.0001	0.3525
Marital status									
Married / partners	51.7	49.5, 53.9	34.0	31.4, 36.7	23.4	21.1, 25.8			
Single	35.2	33.3, 37.1	25.6	23.2, 28.3	12.0	10.2, 14.1			
Separated / Divorced	7.6	6.7, 8.7	32.9	27.5, 38.8	21.1	16.4, 26.7			
Widow(er)	5.5	4.8, 6.3	19.6	15.0, 25.3	23.4	18.8, 28.7	<0.0001	<0.0001	<0.0001
Working status									
Working	60.6	58.6, 62.7	34.8	32.4, 37.3	19.6	17.6, 21.7			
Not working	27.6	25.7, 29.5	24.6	21.8, 27.6	22.1	19.3, 25.2			
Student only	10.8	9.7, 12.0	19.0	16.0, 22.4	10.1	7.7, 13.2			
Other	1.0	0.7, 1.4	27.6	15.5, 44.3	16.0	7.8, 30.2	<0.0001	<0.0001	<0.0001
Per capita family income									

≤ 1 minimum wage	49.0	45.0, 53.0	30.7	28.4, 33.1	19.1	16.8, 21.5			
> 1 minimum wage	51.0	47.0, 55.0	32.1	28.8, 35.6	19.5	17.1, 22.1	0.7034	0.0059	0.0317
<i>Education of householder</i>									
Less than High School	43.0	39.3, 46.9	29.9	27.6, 32.2	19.3	17.5, 21.4			
High School or higher	57.0	53.1, 60.7	30.8	28.3, 33.4	19.5	17.3, 21.8	0.8300	0.0083	0.0163
<i>Smoking status</i>									
Non-smoker	70.3	68.5, 72.0	29.4	27.3, 31.5	18.5	16.9, 20.3			
Former smoker	13.6	12.3, 15.1	38.0	33.6, 42.6	24.1	20.5, 28.0			
Current smoker	16.1	14.8, 17.6	28.1	24.6, 32.0	17.7	14.0, 22.2	<0.0001	0.0159	<0.0001
<i>Alcohol intake</i>									
Never	62.7	62.9, 68.4	27.9	26.1, 29.8	19.4	17.7, 21.2			
≤ 3 times per week	30.9	28.5, 33.5	34.9	31.4, 38.5	19.0	16.0, 22.4			
≥ 4 times per week	3.4	2.8, 4.2	30.7	21.4, 41.8	11.3	6.4, 19.2	0.0042	<0.0001	0.0001
<i>Physical activity level</i>									
Do not meet	21.9	19.8, 24.1	25.4	22.7, 28.4	20.4	17.8, 23.2			
Meet the recommendations	78.1	75.9, 80.2	31.6	29.5, 33.8	18.7	17.2, 20.3	0.0028	0.3880	0.0003
<i>Body weight status</i>									
Overweight	30.3	28.6, 32.1	-	-	-	-			
Obesity	19.2	17.8, 20.6	-	-	-	-	-	<0.0001	-

^a Pearson's Chi-square test with the Rao and Scott second-order correction p-values for differences in the prevalence of overweight and obesity in each ISA-Capital survey (each variable vs. BMI categories in each ISA-Capital survey).

^b Pearson's Chi-square test with the Rao and Scott second-order correction p-values for differences in total population prevalence for each variable across ISA-Capital surveys (prevalence of each variable vs. year of each ISA-Capital survey).

^c Pearson's Chi-square test with the Rao and Scott second-order correction p-values for differences in the prevalence of overweight and obesity in the ISA-Capital (aggregate data from ISA-Capital 2003, 2008 and 2015 of each variable vs. BMI categories).

Figure 1: Prevalence of overweight and obesity according to age and sex in the population of Sao Paulo. ISA-Capital 2003 - 2008 - 2015.

*Differences in the prevalence according to the lack of overlap of the 95% confidence intervals.

Table 2 shows the results of the multivariable logistic regression analysis. Excess body weight and obesity were associated with age group, sex, race/skin color, marital status, income, smoking status, physical activity level and ISA-Capital year. Adults were 67% more likely to have excess body weight or obesity compared to adolescents. Older adults were 43% less likely to have excess body weight, but 60% more likely to be obese than adolescents. That is, adolescents were more likely to be overweight, while older adults were more likely to be obese.

Despite women being 20% less likely to have excess body weight than men, the association was inverse, but not significant, when only obesity was evaluated. Those who declared themselves single presented lower odds ratio for both excess body weight and obesity; and those with higher income and former smokers presented higher odds ratio compared to their counterparts. Those who declared themselves non-white presented lower odds ratio for excess body weight, but not for obesity, as well as current smokers. Also, those who meet the physical activity level recommendation were 24% less likely to be obese compared to those who do not meet the recommendation.

An important increase in both excess body weight and obesity occurred across ISA-Capital years ($OR = 1.3$ in 2008 and $OR = 2.2$ in 2015). Due to this alarming growth, the prevalence of excess body weight and obesity was predicted using logistic regression models, considering the scenario observed in the last surveys. The models were adjusted by the same variables of the model presented in Table 2, except marital status. Figure 2 illustrates the projection for the years of 2020, 2025, and 2030, when 77% of the population is expected to have excess body weight if the scenario continues the same observed in previous surveys. By 2030, the

prevalence of obesity is likely to be 19% for adolescents, 54% for adults, and 30% for older adults.

Table 2: Odds ratios of ordered logistic regression on overweight and obesity in the Health Survey of São Paulo (ISA-Capital) 2003, 2008, and 2015 (n=8,682)^a.

	Overweight & Obese vs Not overweight/obese		Obese vs (overweight & not overweight/obese)	
	Total population OR	95% CI	Total population OR	95% CI
<i>Age group (ref. Adolescents)</i>				
Adults (20 - 59 years)	1.67**	1.30, 2.13		Same ^b
Older adults (60 years or more)	0.57**	0.43, 0.75	1.60**	1.21, 2.12
<i>Sex (ref. Male)</i>				
Female	0.80**	0.71, 0.90	1.10	0.94, 1.28
<i>Race/Skin color (ref. White)</i>				
Non-white	0.84*	0.76, 0.94	0.99	0.86, 1.13
<i>Marital status (ref. Married / Common law partners)</i>				
Single	0.43**	0.36, 0.51	0.51**	0.41, 0.63
Separated / Divorced	0.81	0.64, 1.04		Same ^b
Widow(er)	0.96	0.74, 1.24		Same ^b
<i>Working status (ref. Working)</i>				
Not working	1.11	0.93, 1.31		Same ^b
Student only	1.08	0.81, 1.45		Same ^b
Other	0.70	0.42, 1.17		Same ^b
<i>Per capita family income (ref. ≤ 1 minimum wage)</i>				
> 1 minimum wage	1.14*	1.00, 1.30		Same ^b
<i>Education of householder (ref. Less than High School)</i>				
High School or higher	0.91	0.81, 1.02		Same ^b
<i>Smoking status (ref. Non-smoker)</i>				
Former smoker	1.40**	1.21, 1.63		Same ^b
Current smoker	0.67**	0.57, 0.79	0.83	0.66, 1.03
<i>Alcohol intake (ref. Never)</i>				
≤ 3 times per week	1.06	0.93, 1.20		Same ^b
≥ 4 times per week	0.90	0.70, 1.16		Same ^b
<i>Physical activity level (ref. Do not meet the recommendations)</i>				
Meet the recommendations	0.91	0.79, 1.05	0.76*	0.65, 0.89
<i>Year ISA-Capital (ref. 2003)</i>				
2008	1.32**	1.12, 1.52		Same ^b
2015	2.20**	1.81, 2.68		Same ^b

^aThe multiple model was adjusted by age group, sex, self-reported race, marital status, working status, per capita family income, education of householder, smoking status, alcohol consumption, physical activity level, and ISA-Capital year. ^bEstimates for Overweight & Obese vs Not overweight/obese are the same as for Obese vs (Overweight & Not overweight/obese). * p<0.05 **p<0.005

Figure 2: Prevalence of overweight and obesity predicted by logistic regression models for the population of Sao Paulo according to age group for the years of 2020, 2025 e 2030. ISA-Capital.

*Models adjusted by sex, age group, self-reported race/skin color, working status, per capita family income, education of householder, smoking status, alcohol consumption, physical activity level, and ISA-Capital year.

5.1.5 Discussion

Excess body weight, particularly obesity, increased in the population of Sao Paulo from 2003 to 2015, especially in female adolescents and adults. In general, the prevalence increased 31% from 2003 to 2008, and 126% from 2003 to 2015. If this pattern does not change, more than three-quarters of the population will have excess body weight by 2030. Those with higher chance of having both overweight and obesity were adults, those with higher income, and former smokers.

The prevalence of obesity for the total population in ISA-Capital in 2015 (19.2%, 95%CI = 17.8%, 20.6%) was similar to the observed in Sao Paulo in VIGITEL 2016 (18.1%, 95%CI = 16.2%, 20.0%) [17], despite the aforementioned differences between the studies designs: the telephone interviews in people aged 18 years old or more in VIGITEL versus the household interviews in people aged 12 years old or more in ISA-Capital. The frequency of obesity is comparable to other Brazilian State capitals with diverse populations and characteristics, such as Curitiba (18.9%), Boa Vista (18.7%), and Macapá (17.7%) [17]. However, these cities present higher prevalence of both excess body weight and obesity in men, while in Sao Paulo men have higher rates of excess body weight while women have higher rates of obesity. This pattern is consistent with the observed in developed countries over time [1]. The observed differences across the cities suggest that environmental factors, such as urbanization, physical, economic and social contexts, and food environment [10, 36-38], could play an important role regarding sex differences in obesity.

The prevalence of obesity in the city of São Paulo in 2015 among female adolescents (11.2%; 95% CI: 8.4%, 14.7%) is similar to countries such as Australia (11.2%; 95%CI: 6.4%, 17.0%), Turkey (10.9%; 95%CI: 4.0%, 20.8%), and Uruguay

(11.5%; 95%CI: 3.4%, 23.1%) and among male adolescents (7.6%; 95%CI: 5.5%, 10.3%), it is similar to Colombia (7.5%; 95%CI: 3.0%, 14.0%), Switzerland (7.0%; 95%CI: 3.5%, 11.8%), and Kazakhstan (7.8%; 95%CI: 1.5%, 19.0%) [39]. The prevalence among adult women (22.3%; 95%CI: 19.9%, 24.8%) is similar to the observed in European countries such as France (22%; 95%CI: 16.2%, 28.3%), Portugal (22.1%; 95%CI: 16.3%, 28.4%), Spain (23.8%; 95%CI: 18.7%, 29.0%), and Romania (22.5%; 95%CI: 16.7%, 29.1%) [39]. Among adult men (18.6%; 95%CI: 15.8%, 21.7%), the prevalence is comparable to Colombia (18.3%; 95%CI: 12.9%, 24.2%), Panama (18.5%; 95%CI: 12.5%, 25.5%), and Russia (18.9%; 95%CI: 14.0%, 24.5%) [39]. Among older adults, the prevalence of obesity is similar to the observed in Austria (21.3%), Belgium (20.4%), France (20.8%), and Spain (20.9%), considering both sex [40].

In 2015, 30% of the population of Sao Paulo was overweight, with the highest prevalence for adults (36%), especially men (42%), similar to countries such as Spain (42.1%), Germany (42.4%), and Portugal (42.9%) [1]. Although a lot of attention is given to obesity, overweight is also an important public health issue, since the risk of death continuously increases for adults with BMI above 25 kg/m². A study of 67.8 million individuals worldwide showed that 40% of deaths and 38% of the disability-adjusted life years (DALYs) related to high BMI occurred among non-obese individuals, indicating that a significant proportion of the total burden would be missed by focusing exclusively on obese individuals [4]. In addition, since weight gain is usually a gradual process caused by small changes in energy balance over time, for individuals to become obese they must first be overweight during a period of their lives, and this time may be a good opportunity for prevention [41, 42].

The younger population is also a significant target for prevention [20, 41]. Obese adolescents are five times more likely to become obese adults, which increases the potential for morbidity and premature mortality across the life [43]. In the present study, the prevalence of overweight in adolescents from 12 to 19 years old was 19% and they were 43% more likely to have excess body weight compared to older adults. In spite of the lack of change in overweight prevalence across the years, obesity increased significantly, especially in girls. Studies conducted in Brazil observed that, compared to boys, girls are less physically active [44], have more sedentary leisure time [45], skip breakfast more frequently [46], and consume more sugar and sweet food [47], besides the sex disparities in fat metabolism, fat storage, and puberty [48, 49], which are possible explanations for the observed differences.

Another important factor associated with both excess body weight and obesity in the present study was smoking status. Similar to our findings, a study with 499,504 adults from 31 to 69 years-old observed that current smokers were less likely to be obese than never smokers (OR = 0.83; 95% CI: 0.81, 0.86) and former smokers were more likely to be obese than both current smokers (OR = 1.33; 95% CI: 1.30, 1.37) and never smokers (OR = 1.14; 95% CI: 1.12, 1.15), however this association varied according to age, sex, and amount smoked [11]. Several factors may be related to this association, such as the belief that smoking is an effective way of reducing body weight, change in food preference, lower dietary energy intake, higher energy expenditure, or modifications in the metabolism of calories [11]. Between 1990 and 2015, Brazil recorded a sustained progress in tobacco control, the single most important preventable factor for death and illness, with a reduction of 56% in smoking prevalence [50, 51]. However, despite the increasing frequency of

non-smokers observed from 2003 to 2015 in the present study, Sao Paulo remains one of the State capitals in the country with the highest tobacco use [17]. Our results show that, compared to non-smokers, current smokers were less likely to have excess body weight and former smokers presented 46% more chances of having excess body weight and obesity. Even though one of the main reasons cited for not trying to quit smoking is fear of weight gain, research shows that smoking cessation is associated with substantial health benefits, including improved insulin sensitivity even in the presence of weight gain [51]. Thus, policies and interventions focused on both smoking and diet could increase success rate in terms of smoking cessation and prevent weight gain.

Regarding socioeconomic status, which was evaluated using income and education information, excess body weight has increased at all levels of income during the past decades. Although the annual incremental rates indicate an increase in the incidence of obesity among the poorest men and women in Brazil, those with higher income present the highest rates, especially among men [15]. In the city of Sao Paulo, those who earn more than one minimum wage per person per month in the household are 14% more likely to have excess body weight and obesity. These findings may be associated with factors such as food environment, access and food security, as well as built environment and movement from physical to sedentary labor [10, 52]. Our findings of lower odds of non-white for EBW may be also associated to these factors, besides racial and ethnic disparities [53].

Studies have shown that education is inversely associated with excess body weight [9], but in the present study, this association was not statistically significant. Worldwide, the association between socioeconomic status and body weight is

dependent on the level of economic development of the country [10]. Generally, the prevalence of obesity is positively associated with the initial stages of economic growth, as populations go through nutritional and lifestyle transitions with little access to education and health services. As income increases, some habits associated with obesity are adopted, such as television viewing, purchasing and consuming more fast food, convenience foods, and other high-energy and low-quality foods. However, when there is improved access to health services, education, exercise, and healthy food, as associated with behavioral changes, this association declines. Nevertheless, those factors remain limited. In Brazil, only the quartile of women with the highest income has a lower prevalence of overweight than the quartile with the lowest income [54].

Another social factor that has an important role in lifestyle and is also associated to excess body weight is marital status. In the present study, being single significantly reduced the chances of being overweight or obese compared to people who are married or have a common law partner. Similar results were observed in other populations, which had high rates of overweight or obesity relative to adults in other marital status groups, particularly among men [55-57]. On the other hand, research indicates that married adults were generally found to be healthier than adults in other marital status categories, being least likely to have health problems and to engage in risky health behaviors [56].

Taking these factors into account, the prediction models for excess body weight and obesity indicate that an important increase in their prevalence will occur in all age groups if the patterns observed in the latest surveys do not change. Secular trends estimate that 38% of adults will be overweight and 20% will be obese

worldwide by 2030 [58]. As many aspects influence weight gain and the changes in environment in the population level are dynamic, the trends observed in this study may accelerate, stop, or slow. At the same time that some countries have been observing a slowing of increases in obesity prevalence [59, 60], others have reached extreme values, such as American Samoa, in Pacific Islands, where 75% of the general population is considered obese [61]. In USA, projections indicate that over 85% of adults will have excess body weight by 2030 [62]. Therefore, due to the rapid increase in prevalence of excess body weight in Sao Paulo observed in this twelve-year period and the existing uncertainties when making predictions based on past data [63, 64], we highlight the need for continuous surveillance in order to enable the identification, implementation, and evaluation of evidence-based actions to face this public health problem.

Some limitations should be considered in interpreting the findings of the current study. First, the values for height and weight used to calculate the body mass index were self-reported by the individuals during the household interview, which could lead to underestimates of the population prevalence of overweight and obesity, especially if there is a propensity of over-reporting height and/or under-reporting weight. Although self-reported data may be subject to inaccuracies; they were validated in previous study with ISA-Capital population [30], which observed high intraclass correlation between self-reported and measured parameters for weight ($r > 0,94$) and BMI ($r > 0,85$). The agreement between measured and self-reported weight, height and BMI was good, as sensitivity was $>91\%$ and specificity was $>83\%$. In general, the use of self-reported lifestyle habit variables is also vulnerable to biases, but many precautions were taken in the study design to minimize possible

errors, such as the face-to-face interview held in the households, selection of qualified interviewers and training according to the standard operating procedures, besides periodical meetings between the interviewers and the coordinating staff to check if the procedures were being used accurately and to discuss doubts or potential problems. A second limitation is that we could not explore in detail the patterns of income during this period in this manuscript, but the profound economic crises that Brazil passed through the year of 2015 [65] may have had important influence on this association, as we observed an increase in the prevalence of people in the lowest income category in 2015. There is evidence that changes in socioeconomic position across life course influence excess body weight [66, 67], but future longitudinal research is needed to explore this association in different contexts, such as in terms of culture and economic development in low- and middle-income countries. A third limitation, is that due to the fact that overweight and obesity have multifactorial causes, many factors that could be associated to it, such as diet quality, energy intake, sleeping habits, sedentary behavior, psychosocial factors, gut microbiome, in-utero and physical environment, media and marketing exposure, and genetic and epigenetic variations [13, 14], could not be assessed in this analysis; however, as a complex issue, the association of evidences from multiple researches may help to elucidate this public health challenge. Also, we did not account for sexual maturation when evaluating the adolescents, which could influence body weight and fat distribution disproportionally, especially among the youngest adolescents [49]. However, we used the WHO reference for BMI-for-age cutoffs, which considers variations due to the growth of this lifestage [31]. Finally, although we discussed many possible causes for the increases in obesity prevalence, it is important to

observe that the cross-sectional design of the study precludes causal statements. Still, the survey design is adequate to properly answer the proposed objectives in this analysis: identification of individuals with a higher likelihood of disease occurrence for public health purposes [68].

Despite of the limitations, the present study represents the largest investigation of overweight and obesity in the city of São Paulo, with multiple time points and a sampling design that represents all the population aged 12 years and older living in households in the urban area of the city. Furthermore, the projection analysis performed warns for the alarming public health scenario that can be created if there are no effective actions to hamper the observed trend.

5.1.6 Conclusion

Our findings present up-to-date information about the distribution of excess body weight, which increased substantially over a short time and more prominently in specific groups of the population, such as female adolescents and adults. The factors associated with excess body weight, such as gender, income, age group, and smoking status, may provide important information for decision makers and researchers to create or review the existing programs and interventions in order to decrease the trend for the next years.

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5.2 SEGUNDO MANUSCRITO

Differences over 12 Years in Food Portion Size and Association with Excess Body Weight in the City of São Paulo, Brazil

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5.2.1 Abstract

Although changes in Brazilian diet have occurred over the last decades, there is no evidence about differences in food portion sizes (FPS) over time. Therefore, we aimed to evaluate the association of FPS with excess body weight (EBW), and to monitor differences in the population from São Paulo, Brazil, from 2003 to 2015. Data came from three cross-sectional population-based studies with 5270 individuals aged ≥ 12 years in 2003, 2008, and 2015. Dietary data were obtained from 24-h recalls. Logistic regression models were used to evaluate the association between FPS and EBW. Over the years, there was a diverse variation in FPS, with an increase in some groups (white meat, salted snacks, coffee/tea, eggs) and decrease in others (rice, red meat, sweets, pasta, sandwiches, cold cuts). The percentage of people reporting the intake of six food groupings (rice, white meat, sweets, fruits, commercial juices, toasts/biscuits) increased in the period. In this population, EBW was associated with larger FPS of 11 of the 30 food groupings investigated (cold cuts, fried snacks, fruit and commercial juices, pizza, red meat, rice, salted snacks, soft drinks, soups, sugar). These findings could support future interventions and policies for optimal food intake in Brazil.

5.2.2 Introduction

In recent years, the portion size of foods (especially energy-dense foods) has been intensively investigated as a possible contributor to the rise in prevalence of excess body weight (EBW, including both overweight and obesity) in diverse populations [1,2]. The connection between EBW and portion size has often been linked to rising portion sizes of commercialized foods [3-5] and amount consumed per eating occasion [6]. In addition, experimental studies in humans have demonstrated that exposure to larger portion sizes for successive days resulted in higher energy intake [7-10], since individuals tend to not compensate the extra calories from larger portion sizes by eating less in the subsequent meals, which may influence body weight status.

However, population studies in different countries have observed inconsistent trends in portion sizes over the years, with portion sizes of some foods decreasing, while others were increasing [11-15]. Additionally, few studies have demonstrated the link between EBW and larger portion sizes in free-living populations [16-18]. In Brazil, where more than half of the population have EBW, and one in every five adults is obese [19], only two studies have investigated the association between food portion sizes and EBW. One study with the population of São Paulo in 2008, found a positive association between EBW and larger portion sizes of pizza, red meat, rice, salted snacks, and soft drinks [20]. The other study, investigating the portion sizes of beverages in a representative sample of the country, found a positive association between alcoholic beverages and soft drinks and excess body weight [21].

Although changes in Brazilian dietary patterns have occurred over the last decades in parallel with the rise in the prevalence of EBW [22,23], as far as we

know, there is no evidence about differences on food portion sizes (which are defined as the weight of food or beverage in grams consumed per eating occasion) over the time. Therefore, the aim of this study was to evaluate the association of food portion sizes with body weight status, and to monitor the differences over the years in a representative population from the city of São Paulo, Brazil, from 2003 to 2015.

5.2.3 Materials and Methods

Study Design and Population

Data were collected from three cross-sectional samples of individuals from São Paulo city, Southeastern Brazil, who were interviewed in the Health Survey of São Paulo (ISA-Capital) conducted in 2003, 2008 and 2015. ISA-Capital is a population-based study with a probability sample of individuals living in permanent households located in the urban area of São Paulo, with sampling stratified by clusters carried out in two stages to ensure representativeness at population level: urban census tracts and households. Details of the 2003, 2008 and 2015 surveys, including the sampling design and the sample size calculation, were previously published [24-26].

The samples of the present study included participants residing in São Paulo, aged 12 years or older, of both sexes, and, in the case of women, not being pregnant or lactating during data collection. A sub-sample of the ISA-Capital was drawn to compose the “Health Survey of São Paulo with Focus in Nutrition Study” (ISA-Nutrition). Nutritional information was collected from 2398 individuals from 2003 ISA-Nutrition, 1662 individuals from 2008 ISA-Nutrition, and 1742 from 2015 ISA-Nutrition. Individuals with incomplete anthropometric data required for body mass index (BMI) calculation were excluded from the analysis, resulting in 2100, 1586

and 1689 individuals respectively. In order to ensure data quality, the extreme values of energy intake (below the 1st percentile and above the 99th percentile by sex) were excluded, resulting in 2060, 1556 and 1654 individuals per respective cycle. The final sample for this study comprised 5270 participants: 1711 adolescents, 1865 adults and 1143 older adults.

This survey was approved by the Ethics Committee on Research of the School of Public Health, University of São Paulo (reference number # 56958916.5.0000.5421). Written informed consent/assent was obtained from all participants before commencement of the study.

Data Collection

Demographic, socioeconomic, and lifestyle data were collected from households using a structured questionnaire administered by trained interviewers. The following variables were used for the present study: age, categorized in age groups (adolescents: from 12 to 19 years old, adults: from 20 to 59 years old, and older adults: aged 60 years or more); sex (male or female); self-reported race / skin color (white or non-white); per capita family income (calculated by summing the monetary income reported by all family members and dividing by the number of family members, the values were classified as ≤ 1 minimum wage, or > 1 minimum wage according to the survey year); and householder education level (measured in years of schooling and categorized as ≤ 9 (completed elementary school) or > 9 years of study (high school or more) and considering householder as the person responsible for the family or head of the family). Participants were classified according to their smoking status as current, former, or never smoker. Alcohol consumption was classified as $\leq$

3 times per week, > 3 times per week, or never. Global physical activity level was obtained from the International Physical Activity Questionnaire - IPAQ long version [27] which was validated for the Brazilian population [28], and participants were classified as meeting or not meeting the recommendation according to World Health Organization (WHO) guidelines [29].

Self-reported height and weight were used to calculate the BMI (BMI = weight (kg)/height (m)²), which was used to classify the individuals according to body weight status as without vs. with excess body weight as follows (1) adolescents: BMI < p85 vs. BMI ≥ p85 [30]; (2) adults: BMI < 25 kg/m² vs. BMI ≥ 25 kg/m² [31]; (3) older adults: BMI < 28 kg/m² vs. BMI ≥ 28 kg/m² [32].

Food consumption information was obtained from a 24-h dietary recall (24HR) collected by trained interviewers, representing all days of the week, and season of the year, using the procedures of the Multiple Pass Method (MPM). The respondent, in this process, is guided through five sequential steps: quick list, forgotten foods list, meal time and eating occasions, detail cycle (which includes portion sizes consumed) and final probe. This standardized process maintains the attention of the respondents, which helps them recall all items consumed and reduces respondent burden [33]. Participants were instructed to inform amounts of foods and beverages in household measures and describe them as detailed as possible, including eating occasions, meal time, cooking methods, seasonings and brand names. To guide the estimation of the portion sizes, manuals with photos of household measures were provided to individuals. In specific situations, where the participant could not report the amount consumed, e.g., amount of salt and oil used for salad seasoning, a standard portion

was included. During all data collection, quality control of the 24HR was conducted in order to identify and correct possible reporting errors.

After dietary data collection, all household measures reported in each 24HR were converted into grams and milliliters according to Brazilian publications [34,35]. Food consumption data were entered in the Nutrition Data System for Research (NDSR) software (version 2014), developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, United States of America, which uses the food composition table developed by the United States Department of Agriculture as main data source. The nutritional values of the foods present in the program were compared with the nutritional values of foods available in Brazilian national tables [36]. A consistency analysis of dietary data was performed to identify and correct possible errors in processing and data collection.

Food Grouping

Around 1400 different foods and preparations were reported in all 24HR, which were classified into 46 food groupings, in order to determine those that mostly contributed to the total energy intake of residents in São Paulo city. The food grouping was based on the frequency of consumption, nutritional value and dietary habits of São Paulo population. Foods and mixed dishes (such as feijoada, yakisoba and risotto) consumed by less than 5% of the population were not organized for grouping due to the low prevalence and high variability of nutritional values. Details of food grouping are reported in a previous ISA-Nutrition study by Pereira et al. [20] and the list of foods that were included in each food grouping is described in Table S1.

Table S1. List of foods that were included in each food grouping.

Food groupings	Description of food group contents
Alcoholic beverages	Fermented and distilled alcoholic beverages
Beans	Black and brown beans
Breads and rolls	White and brown bread and rolls
Butter and margarine	Butter and margarine
Cakes	Cakes with or without topping and filling
Cheese	Cheeses, all types
Coffee and tea	Coffee and tea, caffeinated or decaffeinated
Cold Cuts	Ham, salami, roast beef, turkey ham
Commercial juices	Ready-to-drink juices, powder juices, nectar, etc. With or without sugar
Eggs	Boiled, fries, scrambled eggs
Flavored powder	Artificially flavored powders: chocolate, strawberry, etc.
Flavored Snacks	Potato chips, flavored snacks
Fried Snacks	French fries, onion rings, fried cornmeal mush
Fruits	Banana, apple, papaya, melon, mango, citrus fruit, etc.
Fruit juices	Lemonade, pineapple, orange, passion fruit juices, etc. With or without sugar
Leafy vegetables	Lettuce, cabbage, escarole, kale, etc.
Milk	Whole, lowfat, skimmed and fortified milks
Pasta	Spaghetti, ravioli, noodles, cannelloni, lasagna, etc. With or without sauce
Pizza	Sweet (e.g., chocolate) or salt (e.g., mozzarella) pizza
Red meat	Beef, hamburger, liver, ribs, jerked beef, lamb, pork, etc.
Rice	White and brown rice
Salted snacks	Fried or baked savory snacks, e.g., "esfiha", "coxinha", croissant, cheese bread, etc.
Sandwiches	Hamburguer, cheeseburger, cold cut sandwiches, etc.
Soft drinks	Fruit-flavored drinks, cola and noncola soft drinks, light and diet soft drinks
Soups	Soups and creams, including with vegetables or pasta
Sugar	Added sugar, white or brown
Sweets	Chocolate, puddings, ice creams, sweet rolls and pies, etc.
Toast and biscuits	White and brown toasts, savory or sweet biscuits and crackers, with or without filling
Tubers and roots	Potato, cassava, yams, sweet potato
Vegetables	Carrots, tomato, eggplant, broccoli, cucumber, radish, etc.
White meat	Chicken, turkey, fish and seafood

For portion size analysis, we considered food groupings that contributed up to 90% of total energy intake using the method proposed by Block et al [37], additionally to those consumed by at least 10% of the population, resulting in 31 food groupings analyzed, as described in the results section (Figure 1).

Figure 1. Percentage of energy contribution (%) of food groupings consumed by the population of the ISA-Nutrition in 2003, 2008, and 2015. (a) Description of total population; (b) Description of adolescents; (c) Description of adults; (d) Description of older adults. The list of foods included in each food grouping is described in Table S1.

Portion Size, Energy Density, and Energy Intake/Estimated Energy Requirement Ratio

Portion size was defined as total amount of food or beverage in grams that a person consumed at a particular meal occasion [38]. It was estimated by the total intake (in grams) of the items included in the food grouping, divided by the number of eating occasions in which the food grouping was consumed by each individual. For example, if the participant reported the intake of one medium ladle of brown beans for lunch and one medium ladle of brown beans for dinner, her/his portion size is 86 g. However, if the participant reported the intake of two medium ladles of brown beans for lunch and did not consume beans in any other meal, her/his portion size is 172 g. As the intention of this study is to show changes in the average portion size for those who consume a specific item, only individuals who consumed a certain food grouping were included in the analysis of this group.

Energy density (defined as the amount of energy per gram of food) was estimated for each individual dividing the daily energy intake reported on the 24HR (EI, in kcal) by the total amount consumed, in grams. EI of each 24HR was estimated according to Food and Agriculture Organization of the United Nations (FAO) methodology [39], which determines energy conversion coefficients of nutrients more accurately than other traditional methods. It takes into account the digestion and absorption of nutrients, reflecting the amount of energy that can actually be used by the human organism and considered in equation energy balance. Besides considering the energy value attributable to alcohol consumption, this method also distinguishes the energy value of available carbohydrate (starch polysaccharides),

which would be 4 kcal/g, to available energy of fibers, which would be 2 kcal/g, which assumes a mixture of fermentable (70% of total) and non-fermentable fiber.

Energy Intake/Estimated Energy Requirement ratio (EI/EER) was used as a continuous measure in the models investigating the association between EBW and food portion sizes, in order to statistically adjust for energy intake misreporting. A ratio higher than one means overreporting of energy intake, and a ratio lower than one means underreporting. The magnitude of the ratio reflects the difference in the error of energy reporting across the individuals. This method avoids the loss of statistical power that occurs when applying cut-off points to identify under or over-reporters [40]. EER were calculated using the formulas of the Institute of Medicine of the National Academies [41].

Statistical Analysis

Data were analyzed with Stata software version 13.0 (StataCorp, College Station, TX, USA) in survey mode, considering the sample design and weights for population representativeness. General and dietary variables were described using absolute and relative frequencies. Differences between the variables by BMI category (without EBW versus with EBW) were tested according to Pearson's chi-square test for categorical variables, and Mann–Whitney tests for continuous non-parametric variables. Unregistered variables were encoded as missing. Descriptive statistics were used to describe prevalence of consumers, mean, median of the portion sizes (in g), and standard error of each food grouping for consumers only.

The association between food portion sizes (continuous variable) and EBW (dependent variable), were evaluated by stepwise forward logistic regression models

controlling for confounding factors. The models were adjusted for dietary energy density (kcal/g), age (years), gender (male or female), racial self-identification (white or non-white), household income (≤ 1 or > 1 minimal wage per person in the family), householder education (≤ 9 or > 9 years), smoking status (never, former, or current smoker), alcoholic beverages intake (never, ≤ 3 times per week, or > 3 times per week), physical activity level (meet or do not meet WHO recommendation), Energy intake/Estimated Energy Requirement ratio, day of the week (weekday or weekend), intention to lose weight (yes or no), number of eating occasions, and survey year (2003, 2008, or 2015). The model for beans was additional adjusted for intake of rice according to the procedure of Mattei et al. [42], due to high correlation ($r = 0.6434$ $p < 0.0001$) between these two foods in this Brazilian population that customarily consume them together, and rice being the most frequently consumed food and highest contributor to energy intake. Results were presented as odds ratios (OR) and 95% confidence intervals (95% CI) for 10 g of each food grouping, considering a significance level of 5%.

5.2.4 Results

Survey Participant Characteristics

The characteristics of the population evaluated in ISA-Nutrition 2003, 2008, and 2015 are described in Table 1, according to body weight status. Over the three survey periods, the percentage of participants in the total population in the following categories increased across the three survey periods (2003, 2008, and 2015): older adults and adolescents, and participants who self-identified as non-white; with higher householder education; lower income; and who never drink alcohol or smoke. The

prevalence of EBW in the period increased mostly among adolescents and adults. Besides the difference in the prevalence of EBW according to age group, in 2003, those self-identified as white, with higher income, and current smokers presented more EBW. In 2008, the higher EBW prevalence remained among those with higher income, but also in those who met the physical activity recommendations, and former smokers. In 2015, former smokers and those who consumed alcoholic beverages three or less times per week had more EBW.

Regarding the dietary intake of the studied population, the total daily energy intake slightly increased while the total grams decreased, resulting in a marginally smaller dietary energy density from 2003 (1.26 kcal/g) to 2015 (1.22 kcal/g), especially in the ISA-Nutrition -2008 (1.19 kcal/g). Despite the decrease in energy density for total population, it has increased over the years for those with EBW. In the period, small magnitudes in the differences of the energy contribution were observed for protein (from 17.1% in ISA-Nutrition -2003 to 17.2% in ISA-Nutrition -2015) and carbohydrates (from 47.7% in ISA-Nutrition-2003 to 48.1% in ISA-Nutrition -2015). The Energy intake/Estimated Energy Requirement (EI/EER) ratio was higher for those without EBW, indicating less underreporting in this population.

Table 1. Characteristics of the population in the ISA-Nutrition in 2003, 2008 and 2015, according to body weight status^a

		ISA-Nutrition 2003							ISA-Nutrition 2008						
		Total Population		Without EBW		With EBW		<i>p</i> ^c	Total Population		Without EBW		With EBW		
		<i>(n</i> = 2060)		<i>(n</i> = 1427) ^b		<i>(n</i> = 633) ^b			<i>(n</i> = 1556)		<i>(n</i> = 997) ^b		<i>(n</i> = 559) ^b		
		%	95% CL	%	95% CL	%	95% CL		%	95% CL	%	95% CL	%	95% CL	
Age group															
	Adolescents (12–19 years)	17.5	(15.6, 19.6)	82.2	(82.8, 89.1)	13.8	(10.9, 17.2)		24.3	(21.2, 27.6)	75.2	(70.7, 79.3)	24.8	(20.7, 29.3)	
	Adults (20–59 years)	70.1	(68.0, 72.1)	59.0	(55.5, 62.6)	41.0	(37.4, 44.6)		62.6	(58.9, 66.1)	53.1	(48.7, 57.4)	46.9	(42.6, 51.3)	
	Older adults (60 years or more)	12.4	(10.8, 14.2)	64.1	(59.2, 68.6)	36.0	(31.4, 40.8)	0.000	13.2	(11.0, 15.7)	66.0	(61.9, 69.8)	34.0	(30.2, 38.1)	0.000
Gender															
	Female	52.4	(49.5, 55.2)	66.5	(62.8, 69.9)	33.6	(30.1, 37.2)		54.3	(51.8, 56.8)	61.8	(57.8, 65.5)	38.3	(34.5, 42.2)	
	Male	47.6	(44.8, 50.4)	62.1	(57.7, 66.3)	37.9	(33.7, 42.3)	0.145	45.7	(43.1, 48.2)	58.2	(53.3, 63.0)	41.8	(37.0, 46.7)	0.259
Racial Self-identification															
	White	67.2	(63.2, 71.0)	61.9	(58.7, 65.1)	38.1	(34.9, 41.3)		60.5	(54.7, 65.9)	59.5	(55.7, 63.2)	40.5	(36.8, 44.3)	
	Non-white	32.8	(29.1, 36.8)	69.6	(65.4, 73.5)	30.4	(26.5, 34.6)	0.004	39.5	(34.0, 45.3)	61.2	(55.4, 66.7)	38.8	(33.3, 44.6)	0.435
Education of parent/householder															
	≤9 years	54.0	(49.5, 58.4)	65.3	(61.8, 68.7)	34.7	(31.3, 38.2)		46.8	(40.4, 53.2)	60.7	(56.1, 65.1)	39.3	(34.9, 43.9)	
	>9 years	46.0	(41.6, 50.5)	63.5	(58.9, 67.8)	36.5	(32.2, 41.1)	0.521	53.3	(46.8, 59.6)	59.5	(55.5, 63.4)	40.5	(36.6, 44.5)	0.675
Household income ^d															
	≤1 MW ^d	38.5	(34.0, 43.2)	68.4	(63.6, 72.9)	31.6	(27.1, 36.4)		44.3	(39.1, 49.5)	65.6	(61.3, 69.7)	34.4	(30.3, 38.7)	
	>1 MW ^d	61.5	(56.8, 66.0)	61.9	(58.4, 65.3)	38.1	(34.7, 41.6)	0.041	55.7	(50.4, 60.9)	55.8	(51.9, 59.6)	44.2	(40.4, 48.1)	0.000
Leisure-time Physical Activity Level															
	Meet the recommendation	22.7	(19.9, 25.8)	62.2	(56.8, 67.3)	37.8	(32.7, 43.2)		22.2	(20.3, 24.4)	57.4	(50.3, 64.2)	42.6	(35.8, 50.7)	
	Don't meet the recommendation	77.3	(74.2, 80.1)	65.0	(62.0, 67.9)	35.0	(32.1, 38.0)	0.339	77.8	(75.6, 79.7)	61.1	(57.5, 64.5)	38.9	(35.5, 42.5)	0.362

Global Physical Activity Level														
Meet the recommendation	77.2	(74.0, 80.1)	65.8	(61.1, 70.3)	34.2	(29.7, 38.9)		79.8	(77.0, 82.4)	58.4	(55.1, 61.7)	41.6	(38.3, 44.9)	
Don't meet the recommendation	22.8	(19.9, 26.0)	64.1	(61.0, 67.1)	35.9	(32.9, 39.0)	0.517	20.2	(17.6, 23.0)	67.0	(61.0, 72.4)	33.0	(27.6, 39.0)	0.008
Smoking status														
Never	65.9	(62.9, 68.8)	65.8	(62.4, 69.0)	34.2	(31.0, 37.6)		66.4	(63.1, 69.5)	63.2	(59.7, 66.5)	36.8	(33.5, 40.3)	
Former	19.2	(16.6, 22.0)	70.4	(63.1, 76.8)	29.6	(23.2, 36.9)		15.4	(12.9, 18.3)	46.7	(39.0, 54.5)	53.3	(45.5, 61.0)	
Current	15.0	(12.4, 17.9)	50.1	(52.4, 57.3)	49.9	(42.6, 57.2)	0.000	18.2	(15.4, 21.4)	60.5	(53.4, 67.1)	39.5	(32.9, 46.6)	0.000
Alcohol intake														
Never	46.1	(42.5, 49.7)	67.4	(63.4, 71.2)	32.6	(28.8, 36.6)		50.0	(46.7, 53.2)	63.4	(59.3, 67.3)	36.6	(32.7, 40.7)	
≤3 times per week	48.6	(45.0, 52.2)	62.0	(57.9, 65.9)	38.0	(34.1, 42.1)		44.8	(41.6, 48.1)	57.3	(52.2, 62.2)	42.7	(37.8, 47.8)	
>3 times per week	5.32	(4.10, 6.88)	57.6	(44.1, 70.1)	42.4	(29.9, 55.9)	0.110	5.23	(4.0, 6.8)	54.7	(42.5, 66.4)	45.3	(33.6, 57.5)	0.094
	mean	IQR	mean	IQR	mean	IQR	p^c	mean	IQR	mean	IQR	mean	IQR	p^c
Dietary intake														
Total energy (kcal/day)	1826	(1235, 2304)	1849	(1269, 2290)	1786	(1204, 2310)	0.214	1932	(1256, 2430)	1994	(1318, 2488)	1838	(1177, 2321)	0.002
EI/EER	0.71	(0.49, 0.87)	0.74	(0.50, 0.92)	0.65	(0.46, 0.81)	0.000	0.77	(0.50, 0.96)	0.82	(0.55, 1.02)	0.69	(0.44, 0.84)	0.000
Total grams (g/day)	1547	(1041, 1847)	1517	(1065, 1833)	1602	(998, 1900)	0.461	1666	(1130, 2047)	1699	(1161, 2067)	1616	(1075, 1999)	0.037
Total energy density (kcal/g)	1.26	(1.00, 1.47)	1.26	(1.00, 1.47)	1.25	(0.98, 1.47)	0.479	1.19	(0.97, 1.36)	1.21	(1.00, 1.38)	1.17	(0.95, 1.35)	0.026
Protein (%kcal)	17.1	(13.3, 19.9)	16.9	(13.1, 19.8)	17.5	(13.6, 20.4)	0.102	17.4	(13.2, 10.4)	17.1	(13.2, 19.8)	17.7	(13.2, 21.0)	0.074
Carbohydrates (%kcal)	47.7	(41.48, 53.7)	48.4	(42.5, 53.9)	46.3	(40.2, 52.9)	0.002	47.5	(41.5, 54.3)	47.8	(41.6, 54.5)	47.0	(40.6, 54.2)	0.425
Total Fat (%kcal)	32.7	(27.3, 38.3)	32.4	(26.9, 37.8)	33.2	(28.0, 38.9)	0.097	32.4	(26.5, 38.0)	32.4	(26.7, 38.0)	32.3	(26.3, 38.2)	0.910

Abbreviations: EBW, Excess body weight (includes overweight and obesity); 95% CL, 95% Confidence Limits; MW, Minimum Wage; EI/EER, Energy intake/Estimated Energy Requirement ratio; IQR, Interquartile Range. ^a All the analyses took into account the survey sampling design. ^b Without EBW: BMI < p85; With EBW: BMI ≥ p85 for adolescents [30]. Without EBW: BMI < 25 kg/m²; With EW: BMI ≥ 25 kg/m² for adults [31]. Without EBW: BMI < 28 kg/m²; With EBW: BMI ≥ 28 kg/m² for older adults [32]. ^c Categorical variables were compared using Chi Square tests and continuous variables were compared using Mann-Whitney tests. ^d Values were adjusted by the number of individual in the household. One MW is approximately 78 US dollars in 2003, 217 US dollars in 2008, and 236 US dollars in 2015.

Table 1 (Cont). Characteristics of the population in the ISA-Nutrition in 2003, 2008 and 2015, according to body weight status^a

		ISA-Nutrition 2015						<i>p</i> -Values for the Difference Across Surveys ^c			
		Total Population (<i>n</i> = 1654)		Without EBW (<i>n</i> = 969) ^b		With EBW (<i>n</i> = 685) ^b					
		%	95% CL	%	95% CL	%	95% CL	<i>p</i> ^c	Total Population	Without EBW	With EBW
Age group											
	Adolescents (12–19 years)	22.8	(20.5, 25.3)	70.6	(65.9, 74.9)	29.4	(25.2, 34.1)				
	Adults (20–59 years)	54.3	(51.5, 57.0)	45.8	(41.5, 50.2)	54.2	(49.8, 58.5)				
	Older adults (60 years or more)	22.9	(20.1, 26.0)	63.1	(58.3, 67.6)	36.9	(32.4, 41.7)	0.000	0.000	0.000	0.000
Gender											
	Female	49.7	(46.8, 52.7)	54.5	(50.9, 58.1)	45.5	(41.9, 49.1)				
	Male	50.3	(47.3, 53.2)	56.3	(52.1, 60.4)	43.7	(39.6, 47.9)	0.482	0.112	0.054	0.673
Racial Self-identification											
	White	50.4	(46.5, 54.2)	53.5	(49.1, 57.9)	46.5	(42.1, 50.9)				
	Non-white	49.7	(45.8, 53.5)	57.2	(53.1, 61.1)	42.8	(38.9, 46.9)	0.233	0.000	0.000	0.000
Education of parent/householder											
	≤9 years	45.0	(40.8, 49.3)	56.2	(52.4, 59.9)	43.8	(40.1, 47.6)				
	>9 years	55.0	(50.7, 59.2)	54.4	(49.6, 59.2)	45.6	(40.8, 50.4)	0.586	0.028	0.056	0.099
Household income ^d											
	≤1 MW ^d	49.9	(44.8, 54.9)	54.3	(50.2, 58.2)	45.8	(41.8, 49.8)				
	>1 MW ^d	50.1	(45.1, 55.2)	53.8	(48.7, 58.7)	46.3	(41.3, 51.3)	0.881	0.007	0.031	0.003
Leisure-time Physical Activity Level											
	Meet the recommendation	21.9	(19.5, 24.6)	58.2	(51.7, 64.5)	41.8	(35.5, 48.3)				
	Don’t meet the recommendation	78.1	(75.4, 80.5)	54.6	(51.7, 57.6)	45.4	(42.4, 48.3)	0.286	0.883	0.755	0.407

Global Physical Activity Level										
Meet the recommendation	74.6	(71.6, 77.4)	59.4	(53.8, 64.7)	40.6	(35.3, 46.2)				
Don't meet the recommendation	25.4	(22.6, 28.4)	54.3	(50.9, 57.6)	45.7	(42.4, 49.1)	0.130	0.076	0.209	0.050
Smoking status										
Never	71.0	(68.1, 73.7)	56.4	(53.0, 59.8)	43.6	(40.2, 47.0)				
Former	15.0	(12.8, 17.6)	44.3	(37.8, 50.9)	55.7	(49.1, 62.2)				
Current	14.0	(12.1, 16.1)	62.0	(54.1, 69.4)	38.0	(30.6, 45.9)	0.002	0.023	0.000	0.013
Alcohol intake										
Never	58.6	(54.5, 62.6)	58.8	(55.2, 62.3)	41.2	(37.7, 44.8)				
≤3 times per week	38.9	(35.0, 42.8)	50.1	(44.8, 55.3)	49.9	(44.7, 55.2)				
>3 times per week	2.55	(1.70, 3.79)	61.1	(45.3, 74.9)	38.9	(25.1, 54.7)	0.010	0.000	0.000	0.003
	mean	IQR	mean	IQR	mean	IQR	p^c	Total Population	Without EBW	With EBW
Dietary intake										
Total energy (kcal/day)	1877	(1262, 2344)	1952	(1285, 2472)	1783	(1226, 2208)	0.002	0.00	0.01	0.84
EI/EER	0.72	(0.49, 0.89)	0.78	(0.54, 0.96)	0.65	(0.45, 0.78)	0.000	0.00	0.00	0.97
Total grams (g/day)	1615	(1110, 1967)	1640	(1139, 2018)	1585	(1082, 1913)	0.021	0.02	0.00	0.15
Total energy density (kcal/g)	1.22	(0.98, 1.40)	1.24	(1.00, 1.43)	1.19	(0.97, 1.36)	0.040	0.01	0.08	0.03
Protein (%kcal)	17.2	(13.2, 20.0)	17.2	(13.1, 20.0)	17.1	(13.2, 20.0)	0.767	0.04	0.51	0.34
Carbohydrates (%kcal)	48.1	(42.3, 54.1)	48.5	(42.4, 55.2)	47.6	(42.2, 52.8)	0.033	0.00	0.68	0.08
Total Fat (%kcal)	31.8	(26.7, 37.1)	31.5	(26.3, 36.7)	32.2	(27.3, 37.5)	0.115	0.11	0.05	0.03

Abbreviations: EBW, Excess body weight (includes overweight and obesity); 95% CL, 95% Confidence Limits; MW, Minimum Wage; EI/EER, Energy intake/Estimated Energy Requirement ratio; IQR, Interquartile Range. ^a All the analyses took into account the survey sampling design. ^b Without EBW: BMI < p85; With EBW: BMI ≥ p85 for adolescents [30]. Without EBW: BMI < 25 kg/m²; With EW: BMI ≥ 25 kg/m² for adults [31]. Without EBW: BMI < 28 kg/m²; With EBW: BMI ≥ 28 kg/m² for older adults [32]. ^c Categorical variables were compared using Chi Square tests and continuous variables were compared using Mann-Whitney tests. ^d Values were adjusted by the number of individual in the household. One MW is approximately 78 US dollars in 2003, 217 US dollars in 2008, and 236 US dollars in 2015.

Food Groupings Portion Sizes and Frequency of Intake

For total population, the portion sizes of white meat, salted snacks, coffee and tea, and eggs increased in the analyzed period and the portion sizes of rice, red meat, sweets, pasta, sandwiches, and cold cuts decreased (Table 2). Stratifying for age group (Tables S2–S4), there was a reduction in the portion size: of rice, fruits, commercial juices, tubers and roots, and cold cuts for adolescents; of flavored powder, sweets, sandwiches, and cold cuts for adults; and of fruits, pasta, cold cuts, and vegetables for older adults. In contrast, there was an increase in the portion size: of eggs among adolescents; of white meat, salted snacks, coffee and tea, and eggs among adults; and butter and margarine among older adults. The most consumed food grouping in the population was rice. The next foods ranked by percentage of consumers (> 50%) varied according to the year of survey: in 2003, coffee and tea, breads and rolls, beans, milk, sugar, and red meat were the most consumed food groupings; in 2008, breads and rolls were more consumed than coffee and tea, and sugar and red meat were more consumed than milk; in 2015, compared to 2008, milk returned to being more consumed, followed by red meat, and sugar (Table 2). In the study period, there was an increase in the number of participants who reported the intake of rice, white meat, sweets, fruits, commercial juices, and toasts and biscuits (Table 2). For adolescents, there was higher frequency of intake of rice, red meat, sweets, fruits, flavored snacks, commercial juices, and toasts and biscuits, and a lower frequency of intake of sugar, milk, fruit juices, coffee and tea, and salted snacks. For adults, we observed a higher frequency of sweets, fruits, and commercial juices. For older adults, the frequency of alcoholic beverages, white meat, sweets, fruits, breads and rolls, commercial juices and legumes increased (Tables S2–S4).

Table 2. Frequency of consumption and portion size of food groupings for total population of the ISA-Nutrition in 2003, 2008 and 2015.

Total Population (n = 5270)										
Food Grouping ^a	ISA-Nutrition 2003 (n = 2060)					ISA-Nutrition 2008 (n = 1556)				
	Consumption		Portion Size (g)			Consumption		Portion Size (g)		
	%	SE	Mean	Median	IQR	%	SE	Mean	Median	IQR
Alcoholic beverages	9.3	0.01	732.8	542.4	(602.6, 862.9)	10.2	0.01	726.1	477.2	(590.0, 862.1)
Beans	63.3	0.02	104.3	86.0	(98.6, 110.1)	65.8	0.02	108.6	86.0	(103.2, 114.0)
Breads and rolls	71.4	0.01	62.0	50.0	(59.6, 64.4)	70.9	0.01	63.8	50.0	(61.1, 66.6)
Butter and margarine	47.1	0.02	16.2	15.0	(14.4, 18.0)	41.5	0.02	18.4	15.0	(16.7, 20.0)
Cakes	10.4	0.01	91.5	60.2	(76.7, 106.2)	11.0	0.01	90.0	70.0	(79.5, 100.4)
Cheese	25.6	0.02	37.8	30.0	(34.3, 41.4)	25.6	0.02	37.8	30.0	(34.4, 41.2)
Coffee and tea	75.5	0.01	117.6	96.1	(112.5, 122.7)	69.3	0.02	116.8	97.6	(109.9, 123.8)
Cold Cuts	11.6	0.01	40.1	30.0	(34.2, 46.0)	16.2	0.02	33.9	30.0	(29.5, 38.4)
Commercial juices	17.0	0.01	312.3	257.1	(289.3, 335.2)	25.3	0.02	290.9	240.0	(274.9, 306.9)
Eggs	9.3	0.01	56.5	50.0	(52.8, 60.2)	10.5	0.01	49.4	50.0	(42.6, 56.2)
Flavored powder	12.1	0.01	30.3	25.0	(27.1, 33.6)	12.4	0.01	27.3	24.0	(23.6, 30.9)
Flavored snacks	2.5	0.00	75.4	50.0	(35.2, 115.5)	3.4	0.01	74.9	60.0	(56.0, 93.8)
Fried snacks	5.7	0.01	117.6	100.0	(101.3, 133.9)	6.0	0.01	145.8	100.0	(118.4, 173.3)
Fruit juices	20.8	0.01	446.9	251.6	(155.4, 738.5)	20.1	0.01	268.5	240.4	(248.9, 288.0)
Fruits	28.8	0.02	163.4	135.0	(152.6, 174.1)	34.1	0.02	172.4	142.0	(157.6, 187.3)
Leafy Vegetables	40.2	0.02	40.5	30.0	(36.4, 44.6)	40.3	0.01	41.6	30.0	(37.6, 45.7)
Milk	62.7	0.01	170.4	148.5	(161.8, 178.9)	58.5	0.02	162.8	128.9	(154.3, 171.3)
Pasta	19.9	0.01	238.5	238.8	(219.7, 257.2)	19.3	0.01	214.8	208.8	(198.0, 231.6)
Pizza	7.2	0.01	299.7	286.5	(253.1, 346.2)	7.7	0.01	229.3	190.3	(196.3, 262.3)
Red meat	57.1	0.01	112.5	100.0	(107.3, 117.6)	59.9	0.02	116.2	100.0	(107.3, 125.0)
Rice	78.3	0.02	160.8	132.5	(152.5, 169.2)	80.8	0.02	145.0	124.0	(137.3, 152.6)
Salted snacks	17.7	0.01	97.5	71.3	(84.9, 110.1)	16.4	0.01	102.3	73.2	(86.6, 117.9)
Sandwiches	4.3	0.01	223.5	200.0	(196.0, 250.9)	4.9	0.01	169.5	158.9	(142.6, 196.4)
Soft drinks	32.6	0.01	340.4	302.8	(319.4, 361.3)	38.8	0.02	327.2	250.0	(308.8, 345.6)
Soups	9.9	0.02	414.6	329.4	(344.3, 484.9)	4.8	0.01	402.9	325.0	(331.1, 474.8)
Sugar	57.2	0.02	10.1	7.7	(9.28, 11.0)	63.9	0.02	10.2	8.0	(9.49, 10.8)
Sweets	20.7	0.01	87.7	66.7	(80.3, 95.1)	29.2	0.02	84.1	56.0	(75.0, 93.2)
Toast and Biscuits	24.1	0.01	47.1	32.0	(42.1, 52.0)	26.9	0.01	49.6	30.0	(43.8, 55.4)
Tubers and roots	13.9	0.01	118.7	90.0	(101.2, 136.2)	15.6	0.01	132.7	85.0	(92.5, 172.8)
Vegetables	43.1	0.02	75.7	60.0	(68.7, 82.8)	42.6	0.02	79.2	52.5	(67.4, 90.8)
White meat	33.0	0.02	99.3	80.0	(91.3, 107.3)	37.1	0.01	116.5	100.0	(104.1, 128.8)

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^a The list of foods included in each food grouping is described in Table S1. ^b Trend was estimated using logistic and linear regression models.

Table 2 (Cont). Frequency of consumption and portion size of food groupings for total population of the ISA-Nutrition in 2003, 2008 and 2015.

Total Population (<i>n</i> = 5270)							
Food Grouping ^a	ISA-Nutrition 2015 (<i>n</i> = 1654)					<i>p</i> -Values for Difference Across the Surveys ^b	
	Consumption		Portion Size (g)			Frequency	Portion Size
	%	SE	Mean	Median	IQR		
Alcoholic beverages	10.9	0.01	681.8	351.5	(514.9, 848.7)	0.278	0.638
Beans	66.9	0.02	107.3	86.0	(102.6, 112.1)	0.173	0.409
Breads and rolls	75.2	0.01	58.9	50.0	(56.7, 61.1)	0.057	0.086
Butter and margarine	47.9	0.01	17.4	15.0	(16.5, 18.3)	0.913	0.229
Cakes	12.4	0.01	90.0	60.8	(76.3, 103.7)	0.175	0.881
Cheese	26.6	0.01	35.7	30.0	(32.5, 38.8)	0.673	0.390
Coffee and tea	71.8	0.01	143.8	125.1	(135.1, 152.5)	0.038	0.000
Cold Cuts	12.6	0.01	28.7	20.0	(24.2, 33.2)	0.369	0.003
Commercial juices	28.8	0.02	281.9	240.0	(261.8, 302.0)	0.000	0.054
Eggs	11.9	0.01	70.1	50.0	(62.5, 77.7)	0.075	0.002
Flavored powder	11.8	0.01	27.7	24.0	(24.1, 31.4)	0.854	0.262
Flavored snacks	3.7	0.01	58.9	48.5	(47.6, 70.2)	0.066	0.415
Fried snacks	5.0	0.01	106.7	100.0	(92.8, 120.7)	0.530	0.565
Fruit juices	21.1	0.01	287.0	251.6	(266.8, 307.1)	0.904	0.277
Fruits	45.5	0.02	156.0	131.0	(147.0, 164.9)	0.000	0.258
Leafy Vegetables	42.3	0.02	37.2	30.0	(34.3, 40.1)	0.445	0.224
Milk	59.2	0.02	164.9	148.5	(157.9, 171.9)	0.107	0.297
Pasta	19.2	0.01	192.1	168.2	(168.5, 215.7)	0.718	0.003
Pizza	6.7	0.01	285.9	302.1	(249.4, 322.4)	0.740	0.507
Red meat	58.7	0.02	103.2	92.5	(97.3, 109.0)	0.413	0.027
Rice	82.6	0.01	146.0	125.0	(138.7, 153.3)	0.052	0.007
Salted snacks	15.8	0.01	119.6	100.0	(106.5, 132.6)	0.264	0.022
Sandwiches	3.3	0.01	170.4	158.9	(142.4, 198.3)	0.300	0.007
Soft drinks	30.9	0.01	326.3	275.1	(307.2, 345.3)	0.594	0.312
Soups	7.4	0.01	388.4	392.1	(338.2, 438.6)	0.183	0.561
Sugar	55.1	0.02	10.9	8.1	(9.93, 11.8)	0.614	0.279
Sweets	34.2	0.02	70.5	45.0	(62.6, 78.3)	0.000	0.002
Toast and Biscuits	28.0	0.01	53.8	30.0	(47.1, 60.5)	0.040	0.112
Tubers and roots	16.2	0.01	131.1	80.0	(107.4, 154.7)	0.153	0.396
Vegetables	46.9	0.02	71.4	52.0	(65.3, 77.6)	0.11	0.399
White meat	37.7	0.01	111.8	100.0	(104.5, 119.1)	0.031	0.021

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^a The list of foods included in each food grouping is described in Table S1. ^b Trend was estimated using logistic and linear regression models.

Food Groupings Contribution to Total Energy Intake

The contribution to total energy intake of food groupings that contributed up to 90% of total amount of energy is described in Figure 1. The top three food groupings contributing to energy intake in all the years were rice, breads and rolls, and red meat; only for adolescents, red meat contributed more to energy than breads. The contribution of the other food groupings varied widely across the age groups. For example, in 2015, for adolescents, adults, and older adults respectively, toasts and biscuits were the 4th, 9th, and 11st; salted snacks were the 8th, 10th, and 18th; soft drinks were the 9th, 12th, and 19th; and milk and dairy were the 10th, 8th, and 6th in the ranking of energy contribution.

Over the years, the energy contribution of rice and red meat decreased for total population, and the contribution of white meat, toasts and biscuits, sweets, fruits, and commercial juices increased. Significant changes occurred in the ranking of contribution from 2003 to 2015, such as white meat, which passed from 6th (4.3% of daily energy contribution) to the 4th place (5.5%) in the ranking, soft drinks, which ranked 12th in 2003 (3.2%), 5th in 2008 (4.4%), and 13th in 2015 (3.1%), and sweets, which passed from the 11th position in 2003 (3.5%) to the 7th in 2015 (4.4%). For adolescents, there was an increase in the contribution of toasts and biscuits, sweets, white meat, and commercial juices in the period, and a peak in soft drinks intake in 2008, followed by a reduction to the 2003 level in 2015. For adults, rice and breads had an important reduction in energy contribution, while pizza, salted snacks, and juices presented a reduction in 2008 but increased again in 2015. Butter and margarine, toasts and biscuits, and fruits constantly increased in the period. For

older adults, there was a reduction in the energy contribution of rice and red meat, and an increase in white meat, sweets, butter and margarine, and alcoholic beverages. Moreover, the increase that occurred in 2008 for fruits returned to the same values of 2003 in 2015.

Association with Excess Body Weight

Table 3 describes the results of the logistic regression models evaluating the association between EBW and food portion size. Larger portion sizes of beans, cold cuts, fried snacks, fruit and commercial juices, pizza, red meat, rice, salted snacks, soft drinks, soups, and sugar were associated with higher odds of having EBW.

Table 3. Association of food groupings' portion size for the total population in the Health Survey of São Paulo with excess body weight ^a assessed using logistic regression model.

Food Grouping ^b	<i>n</i> ^d	Adjusted Model for Portion Size ^c		
		OR	95% CI	<i>p</i>
Alcoholic beverages	381	1.003	(0.99, 1.01)	0.276
Beans ^e	3236	1.014	(1.00, 1.03)	0.148
Breads and rolls	3514	1.024	(0.99, 1.06)	0.155
Butter and margarine	2215	1.058	(0.96, 1.16)	0.239
Cakes	510	1.005	(0.97, 1.04)	0.774
Cheese	1161	1.046	(0.98, 1.11)	0.154
Coffee and tea	3469	1.010	(1.00, 1.02)	0.059
Cold cuts	581	1.112	(1.04, 1.19)	0.004
Commercial juices	1066	1.020	(1.01, 1.03)	0.002
Eggs	504	1.096	(1.00, 1.21)	0.062
Flavored powder	635	1.017	(0.94, 1.11)	0.699
Flavored Snacks	171	1.037	(1.00, 1.07)	0.278
Fried snacks	252	1.056	(1.00, 1.11)	0.030
Fruit juices	919	1.014	(1.00, 1.03)	0.044
Fruits	1795	1.004	(0.99, 1.02)	0.440
Leafy vegetables	1927	1.018	(0.98, 1.06)	0.377
Milk	3012	1.001	(0.99, 1.01)	0.867
Pasta	887	1.013	(1.00, 1.03)	0.081
Pizza	290	1.028	(1.01, 1.05)	0.007
Red meat	2779	1.017	(1.00, 1.03)	0.027
Rice	3951	1.025	(1.01, 1.04)	0.000
Salted snacks	799	1.031	(1.01, 1.06)	0.010
Sandwiches	172	0.989	(0.93, 1.05)	0.711
Soft drinks	1589	1.011	(1.00, 1.02)	0.005
Soups	376	1.016	(1.00, 1.03)	0.010
Sugar	2793	1.148	(1.02, 1.29)	0.020
Sweets	1260	1.009	(0.99, 1.03)	0.407
Toast and biscuits	1286	1.009	(0.98, 1.04)	0.578
Tubers and roots	704	1.011	(0.99, 1.03)	0.187
Vegetables	1997	1.016	(1.00, 1.03)	0.089
White meat	1624	0.999	(0.98, 1.02)	0.882

OR, estimated regression coefficient for 10 grams of each food grouping; 95% CI, 95% Confidence Interval. ^a Without EBW: BMI < p85; With EBW: BMI ≥ p85 for adolescents [30]. Without EBW: BMI < 25 kg/m²; With EBW: BMI ≥ 25 kg/m² for adults [31]. Without EBW: BMI < 28 kg/m²; With EBW: BMI ≥ 28 kg/m² for older adults [32]. ^b The list of foods included in each food grouping is described in Table S1. ^c Models adjusted for dietary energy density (kcal/g), age (years), gender (male or female), racial self-identification (white or non-white), household income (≤1 or >1 minimal wage/person), householder education (≤9 or >9 years), smoking status (never, former, or current smoker), alcoholic beverages intake (never, ≤3 times/week, or >3 times/week), physical activity level (meet or do not meet WHO recommendation), Energy intake/Estimated Energy Requirement ratio, day of the week (weekday or weekend), intention to lose weight (yes or no), number of eating occasions, and survey year (2003, 2008, or 2015). ^d Sample size for each regression model. ^e Models for beans portion sizes were further adjusted by rice portion sizes, due to the high correlation between these variables. In bold, p-values<0.05.

5.2.5 Discussion

Over the twelve years of study, there was diverse variation in food portion size intake in the population of São Paulo, with increases in some food groupings (white meat, salted snacks, coffee and tea, and eggs) and decreases in others (rice, red meat, sweets, pasta, sandwiches, and cold cuts). The percentage of people reporting the intake of six food groupings (rice, white meat, sweets, fruits, commercial juices, and toasts and biscuits) increased in the period. In this population, EBW was associated with larger portion sizes of 11 of the 30 food groupings investigated (cold cuts, fried snacks, fruit and commercial juices, pizza, red meat, rice, salted snacks, soft drinks, soups, and sugar).

Studies investigating trends in the food portion sizes at a population level in other countries also observed diversity in the patterns of increasing or decreasing portion sizes. In Ireland, significant increases were observed for ‘white sliced bread’, ‘brown/whole meal breads’, ‘all meat, cooked’, ‘poultry, roasted’ and ‘milk’, significant decreases were observed for ‘potatoes’, ‘chips/wedges’ and ‘ham, sliced’ and five foods did not change significantly over time ‘processed potato products’, ‘bacon/ham’, ‘cheese’, ‘yogurt’ and ‘butter/spreads’ [15]. In the USA, larger portion sizes were reported for several foods including soft drinks, coffee, tea, and ready-to-eat cereal, and smaller portion sizes were reported for fewer foods: margarine, mayonnaise, chicken, macaroni and cheese, and pizza [11]. Some of these results can be comparable to the findings from São Paulo, such as the increase of poultry in Ireland and coffee and tea in USA, and decrease of macaroni and cheese in USA similar to that of pasta in São Paulo. However, the differences illustrates that several

aspects are related to the trends in portion sizes over time, such as culture, economy, social environment, food policies, among others. This highlights the importance of monitoring the trends in each specific population in order to support actions focused specifically for each group.

With respect to the energy contribution of the food groupings, there is a mixed pattern in the population: with an increase in contribution of food groupings related to healthier diet, such as fruits and white meat, in parallel to the reduction of red meat; but also increases of energy contribution of sweets, toasts and biscuits, and commercial juices. These data additionally reinforce the plurality of factors influencing food choices at the population level in terms of both portion size and eating frequency, such as access, taste, nutrition knowledge, cost, convenience, health perception, marketing, and social modelling [43-45], which result in changes over time occurring for both healthier and unhealthier foods.

There is a pattern in the relationship between portion size and energy contribution of the food groupings. For some of them, such as fruits, commercial juices, and toasts and biscuits, there was an increase in the energy contribution, but not in portion size, and for sweets, the portion size decreased in parallel with an increase in energy contribution, indicating that these foods are likely more frequently consumed throughout the day. For other food groupings, such as white and red meat, rice, and pasta, the changes in portion sizes followed the changes in energy contribution, indicating less eating frequency in the same day. This observation is in accordance with previous studies investigating the relationship between EBW and eating occasions, specially snacking. They indicated that higher eating occasions is another important dietary factor linked to EBW, and must be more problematic than

portion size alone. If a food is more frequently consumed, it must increase energy intake even if the portion size remains the same or decrease [46].

Despite many studies having investigated the relationship between food portion sizes and EBW, few have quantified this association in free-living populations. Two studies performed with Irish [16] and English [17] adults found a positive association between EBW and larger portions of “savory snacks, butter, full-fat spreads, meat products and dishes and chips and processed potatoes” and “whole and low-fat milks, potatoes, fresh meat, breads and rolls, low-fat spreads, vegetables, fish, chips and processed potatoes”, respectively. One study with British adolescents found that high-fiber breakfast cereal, cream, and high-energy soft drinks were positively associated with higher BMI after adjusting for misreporting, and larger portions of biscuits, cheese, cream, and cakes were associated with higher BMI after eliminating the effect of underreporting [18].

In a previous study, with 1005 adults from São Paulo in 2008, we observed a positive association between EBW and portion sizes of five food groupings: pizza, red meat, rice, salted snacks, and soft drinks [20]. In the present study, with larger sample size ($n = 5270$) and broader age range (12 years and older), we confirmed the previous associations, and observed additional food groupings: cold cuts, fried snacks, fruit and commercial juices, soups, and sugar. This fact indicates that a variety of food groupings may contribute to EBW. The larger sample size allowed for adjustment of additional confounding factors: in the first study, the portion size models were adjusted for dietary energy density, gender, age, per capita family income, physical activity level, and misreporting. In the present study, the models were further adjusted for racial self-identification, householder education, smoking

status, alcoholic beverages intake, day of the week, intention to lose weight, number of eating occasions, and survey year. Although it is extremely complex to establish a direct link between portion size and EBW in free-living populations, given that many factors besides food portion size influences energy intake, such as number of eating occasions and energy density [47], adjusting for such factors allowed a more complex investigation of the association.

A cohort study with 120,877 U.S. women and men demonstrated that specific dietary factors are associated with long-term weight gain [48]. Increased daily servings of soft drinks, potatoes, red meat, refined grains (including rice), sweets and fruit juices were associated with greater weight gain. In the present study, similar associations were observed for the portion sizes, except for potatoes, which were classified in different ways in both studies, and for sweets, which were not statistically significant in the present study.

Food groupings with high energy and low nutrient density have consistently been associated with EBW [49]. In the present study, larger portions of fried snacks, salted snacks, and pizza are in accordance with this association. An issue of concern is that the portion size of salted snacks increased in the period in the total population and among adults, and the portion sizes of fried snacks and pizza did not decrease. In contrast, the number of adolescents reporting the intake of salted snacks decreased (from 26.3% in 2003 to 20.1% in 2015), although the prevalence of consumers is higher than in the other age groups.

In the present study, the portion size of rice, a traditional staple food in Brazil, was associated with EBW. Despite the consumption of rice concomitantly with beans has been consistently associated with healthier eating patterns [50,51], favorable

weight outcomes in an 18-month randomized trial [52], and reduced BMI and waist circumference in low-income Brazilian women [53], studies indicate that the benefits of this pattern occur mainly because the intake of beans [42,54]. In accordance with our findings, other studies found a positive association between excess body weight and rice intake [42,55], but not with beans after adjusting for the highly-correlated and sizable rice intake [42], as we observed here. A study with 675 consumers in a restaurant serving buffet-by-weight also observed association between large portion size and EBW, even in consumers of rice and beans [56].

Beverage intake, particularly sugar-sweetened beverages, has also been related to EBW in previous studies [48,57,58], besides being an important risk factor for diabetes and triglycerides increase [59,60]. In the present study, the portion sizes of the analyzed beverages were associated with EBW (Fruit juices: OR = 1.014, $p = 0.044$; Commercial juices: OR = 1.020, $p = 0.002$; Soft drinks: OR = 1.011, $p = 0.005$), except coffee and tea (OR = 1.010, $p = 0.059$). Although the beverages food grouping did not discriminate if they were sugar-sweetened or not, the intake of sweeteners other than sugar is extremely low in this population: 90% of the population in 2008 consumed sugar-sweetened beverages. In addition, the portion size of sugar, frequently added to beverages, was also associated with EBW in the present study. Whereas moderate consumption of fruit juice may be an important source of vitamins, minerals, and antioxidants, excessive fruit juice consumption has been associated with weight gain [61], in accordance with the findings of the present study. Another issue regarding beverages in the present study is that regardless of the decrease in the portion size of commercial juices among adolescents over the survey years, the number of participants reporting the intake of this food grouping

significantly increased, not only for adolescents, but also for adults and total population.

Similar to our findings, a study with Brazilian adults from the National Dietary Survey (NDS, $n = 24,527$) observed that the portion size of soft drinks was positively associated with EBW [21], as well as the study with adults from São Paulo in 2008 [20]. The three studies observed that the most frequently consumed beverage group by the population was coffee or tea (71.8% in ISA-Nutrition-2015 and 89.9% in NDS), which presented the smallest portion size among the beverages. There was less consumers of soft drinks in ISA-Nutrition-2015 (30.9%) than in NDS (35.4%), but more consumers of milk (59.2% vs. 31.3%), and alcoholic beverages (10.9% vs. 8.3%). In both studies, alcoholic beverages had the lowest frequency of consumption among the beverages, however they presented the largest portion size. The NDS study found positive association between EBW and portion size of alcoholic beverages ($PR = 1.20$, 95% CI, 1.11–1.29), different from the present study ($OR = 1.003$, 95% CI, 0.99–1.01). These discrepancies may result from methodological aspects of each research study or from characteristics of the population. Indeed, findings have been inconsistent in prior studies of alcohol intake and weight gain [48,62-64], and additional analyses are necessary to better understand this relationship.

Two other food groupings, red meats and cold cuts (considered processed meats), previously associated with EBW [48,65] and other diseases, such as some types of cancer [66], also had the portion size associated with EBW. These foods have been associated with worse diet quality, and have been considered an important source of excessive saturated and trans fats in the Brazilian diet [67].

Some limitations should be considered in the present study. First, the estimation of food portion size has fragilities, since it is based on self-report and is subject to recall bias, inherent to the dietary assessment method. However, a more accurate method, such as weighing, is impracticable in studies with a very large number of individuals, like the ISA-Nutrition. To minimize this error, we used tools to improve the dietary assessment quality, such as the use of figures as references for reporting the amounts of foods, the Multiple Pass Method, interviewer's training, among others. Furthermore, we checked the standardization of the amounts for the household measurements to be sure that they were the same over the surveys. Secondly, the self-report of height and weight might have attenuated the association between BMI and food portion size if heavy individuals inform lower weights as compare to slim ones, however the self-reported data were validated in previous study [68], which observed high intraclass correlation between self-reported and measured parameters for weight ($r > 0,94$) and BMI ($r > 0,85$). Agreement between measured and self-report weight, height and BMI was good, as sensitivity was $>91\%$ and specificity was $>83\%$. A third limitation is the systematic correction of the underreporting. Because underreporting is higher in people with higher BMI [69], it is one of the main problems when comparing dietary intake and EBW. It is strongly recommended that underreporting is taken into account in these associations to better interpret the data and results provided [40]. For this reason, we included in the models the Energy Intake/Estimated Energy Requirement ratio, a specific individual approach to statistically adjust for energy intake misreporting, instead of using cutoff methods, which could artificially elevate the association [40]. However, this method considers that all foods are equally underreported, despite that underreporting is

frequently specific for certain foods, both in regard to consumed amount and to fidelity in reporting or not reporting consumption, according to the perception of being “unhealthy” or associated to obesity [70,71]. However, up to this moment, there is no methodology that considers this differentiation. The correlation between foods consumed together is a fourth limitation. The evaluation of the portion size of foods consumed together may attenuate the association of each food evaluated in a different regression model. Except for the model with the portion size of beans, in which portion size of rice was included due to its extremely high correlation of these two foods in this population, the analysis could not be performed with several food groupings at the same time, since only consumers presented a portion size value, and participants should have consumed all the foods included in the model to enable the analysis.

Despite of the limitations, the present study represents the largest investigation of the relationship between EBW and food portion size, with three time points and a sampling design that represents all the population aged 12 years and older living in households in the urban area of the biggest city in Brazil and one of the most populous cities in the world, with more than 12 million habitants [72]. In addition, important confounders of this association were taken into account, such as energy density and number of eating occasions.

5.2.6 Conclusions

The present study identified lack of consistency in trends of food portion sizes and energy contribution over the twelve years of study in the population of São Paulo, with an increase in some food groupings in parallel with decrease in others.

Portion sizes of 11 different food groupings were associated with EBW. Future interventions and public policies for optimal food intake in Brazil could be supported in light of these findings.

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Table S2: Frequency of consumption and portion size of food groupings for adolescents of the ISA-Nutrition in 2003, 2008 and 2015.

Food Grouping ^a	Total Adolescents (<i>n</i> = 1711)									
	ISA-Nutrition 2003 (<i>n</i> = 677)					ISA-Nutrition 2008 (<i>n</i> = 512)				
	Consumption		Portion size (grams)			Consumption		Portion size (grams)		
	%	SE	mean	median	IQR	%	SE	mean	median	IQR
Alcoholic beverages	3.3	0.01	864.4	582.9	.	4.3	0.01	985.2	703	.
Beans	65.1	0.03	118.2	86	(112.2, 124.3)	63.6	0.03	120	86	(113.5, 126.6)
Breads and rolls	74.8	0.02	71.4	50	(67.9, 75.0)	68.2	0.02	76.1	60	(71.4, 80.7)
Butter and margarine	50.3	0.03	22.1	15	(18.6, 25.6)	40.4	0.02	24.1	22.5	(21.9, 26.3)
Cakes	13.2	0.02	94.1	72	(82.5, 105.7)	14.3	0.02	104.2	90	(79.9, 128.5)
Cheese	23.6	0.02	34.7	30	(30.6, 38.9)	21.9	0.02	39.5	27	(33.4, 45.6)
Coffee and tea	49.8	0.03	125.5	120.1	(112.9, 138.2)	42.3	0.03	130.8	120.1	(119.3, 142.3)
Cold Cuts	14.6	0.01	37.2	30	(29.3, 45.2)	18.4	0.02	36.5	30	(30.8, 42.1)
Commercial juices	22.1	0.02	330.1	308.6	(303.9, 356.3)	35.2	0.02	322.4	252.6	(297.1, 347.7)
Eggs	11.1	0.01	55.8	50	(48.2, 63.3)	6.8	0.01	59.9	50	(50.1, 69.6)
Flavored powder	26.9	0.02	28.2	25	(24.8, 31.5)	25.8	0.02	27.6	27.5	(24.9, 30.4)
Flavored Snacks	5	0.01	68.9	55	(47.9, 89.9)	9	0.01	85.9	66	(70.3, 101.6)
Fried snacks	7.3	0.01	111.6	100	(91.4, 131.7)	8.8	0.01	150	106.4	(100.5, 199.6)
Fruit juices	24	0.02	298.1	251.6	(277.8, 318.3)	19.7	0.02	296.4	251.6	(270.3, 322.4)
Fruits	20.6	0.02	192.3	150	(163.7, 220.9)	19.7	0.02	149.9	135	(131.0, 168.8)
Leafy Vegetables	30.5	0.02	35.2	30	(31.6, 38.7)	29.2	0.02	36.2	30	(31.6, 40.8)
Milk	59.5	0.03	201.9	198	(188.3, 215.4)	54.3	0.02	213.3	198	(197.6, 228.9)
Pasta	22.3	0.02	237.8	225	(208.9, 266.7)	20.8	0.02	218.3	208.8	(195.6, 241.0)
Pizza	6.3	0.01	296.6	286.5	(228.1, 365.2)	9.5	0.02	282.2	200.3	(179.5, 385.0)
Red meat	54.5	0.03	104.8	100	(98.0, 111.5)	61.8	0.02	126.4	100	(108.8, 144.0)
Rice	78.5	0.02	169.1	150	(155.1, 183.0)	76.6	0.02	162.7	135	(153.9, 171.5)
Salted snacks	26.3	0.02	108.1	72	(89.8, 126.3)	22.9	0.02	126.6	94	(105.2, 148.0)
Sandwiches	6.5	0.01	199.4	200	.	8.9	0.01	186.1	186	.
Soft drinks	44.1	0.03	345.1	311.4	(320.5, 369.6)	57.6	0.03	367.9	307.2	(342.1, 393.8)
Soups	7.5	0.02	418.4	330	.	1.5	0.01	629	702.4	.
Sugar	53.4	0.02	12.7	10	(11.1, 14.3)	55.2	0.03	12.7	12	(11.6, 13.8)
Sweets	28.5	0.02	82.7	56.2	(69.6, 95.8)	37	0.03	91.7	61.1	(77.9, 105.6)
Toast and Biscuits	27.4	0.02	72.4	54	(64.3, 80.4)	31.2	0.02	82.4	52.7	(71.6, 93.2)
Tubers and roots	14	0.02	145.1	90	(103.2, 187.0)	11.9	0.01	128.5	90	(86.8, 170.3)
Vegetables	32.5	0.02	59.2	45	(51.8, 66.7)	26.9	0.02	68.2	50	(58.7, 77.7)
White meat	32	0.02	87.9	75	(75.7, 100.0)	30.2	0.02	110.7	90	(94.7, 126.7)

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^a The list of foods included in each food grouping is described in Table S1. ^b Trend was estimated using logistic and linear regression models.

Note: missing standard errors because of stratum with single sampling unit.

Table S2 (Cont): Frequency of consumption and portion size of food groupings for adolescents of the ISA-Nutrition in 2003, 2008 and 2015.

Food Grouping ^a	Total Adolescents (<i>n</i> = 1711)						
	ISA-Nutrition 2015 (<i>n</i> = 522)						p ^b
	Consumption		Portion size (grams)			trend portion	trend freq
	%	SE	mean	median	IQR		
Alcoholic beverages	2	0.01	687.5	564	.	.	0.198
Beans	70.8	0.02	115	106	(107.7, 122.2)	0.487	0.139
Breads and rolls	70.2	0.02	66.8	50	(62.8, 70.8)	0.101	0.119
Butter and margarine	44.9	0.02	19.3	15	(16.8, 21.8)	0.223	0.154
Cakes	12.6	0.02	86.8	60	(69.6, 104.5)	0.507	0.765
Cheese	20.6	0.02	33.8	22.5	(28.3, 39.2)	0.835	0.312
Coffee and tea	40.1	0.02	143.4	130.6	(130.2, 156.7)	0.058	0.008
Cold Cuts	15.2	0.02	27.6	20	(22.6, 32.6)	0.043	0.812
Commercial juices	43.1	0.02	287.6	240	(263.7, 311.4)	0.012	0
Eggs	13.1	0.02	70.6	50	(57.8, 83.5)	0.05	0.373
Flavored powder	26.8	0.02	31	25	(25.0, 37.0)	0.427	0.984
Flavored Snacks	9.5	0.02	59.5	48	(43.2, 75.9)	0.292	0.015
Fried snacks	6.5	0.01	128.3	100	(96.6, 160.0)	0.347	0.618
Fruit juices	17.7	0.02	287	251.6	(258.9, 315.1)	0.539	0.034
Fruits	31.6	0.02	154	131	(134.1, 173.9)	0.041	0.001
Leafy Vegetables	29.4	0.02	35.7	30	(30.4, 40.9)	0.882	0.755
Milk	51.8	0.03	206.6	198	(193.2, 219.9)	0.595	0.048
Pasta	21.1	0.02	207.4	208.8	(181.7, 233.2)	0.125	0.717
Pizza	5.8	0.01	259.2	181	(209.6, 308.7)	0.385	0.777
Red meat	63.8	0.02	97.8	90	(89.3, 106.4)	0.139	0.012
Rice	87.1	0.02	144.7	125	(135.4, 153.9)	0.004	0.006
Salted snacks	20.1	0.02	121	89.9	(100.5, 141.4)	0.311	0.035
Sandwiches	3.3	0.01	200.1	228	.	.	.
Soft drinks	40.2	0.03	337.8	311	(309.7, 365.9)	0.743	0.289
Soups	2.8	0.01	383.2	390	.	.	.
Sugar	44.6	0.02	11.8	9	(9.99, 13.6)	0.506	0.011
Sweets	45.5	0.03	66.8	38	(53.9, 79.6)	0.052	0
Toast and Biscuits	34.5	0.02	77.4	50	(64.3, 90.5)	0.58	0.014
Tubers and roots	14.7	0.02	96.2	70	(73.5, 118.9)	0.043	0.809
Vegetables	33.6	0.02	63.5	50	(54.9, 72.0)	0.474	0.732
White meat	35.6	0.02	100.5	98	(90.6, 110.4)	0.136	0.267

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^a The list of foods included in each food grouping is described in Table S1. ^b Trend was estimated using logistic and linear regression models.

Note: missing standard errors because of stratum with single sampling unit.

Table S3: Frequency of consumption and portion size of food groupings for adults of the ISA-Nutrition in 2003, 2008 and 2015.

Food Grouping ^a	Total Adults (<i>n</i> = 1865)									
	ISA-Nutrition 2003 (<i>n</i> = 692)					ISA-Nutrition 2008 (<i>n</i> = 560)				
	Consumption		Portion size (grams)			Consumption		Portion size (grams)		
	%	SE	mean	median	IQR	%	SE	mean	median	IQR
Alcoholic beverages	11.1	0.01	762.4	602.6	(610.1, 914.7)	13.2	0.02	735.6	500.6	(577.9, 893.3)
Beans	62.9	0.02	104.1	86	(96.9, 111.2)	66.3	0.03	108.9	86	(100.9, 116.9)
Breads and rolls	70	0.02	61.6	50	(58.4, 64.8)	70.4	0.02	62.1	50	(58.7, 65.6)
Butter and margarine	46.9	0.02	15.2	15	(13.3, 17.0)	40.9	0.02	16.8	15	(14.6, 19.0)
Cakes	10.6	0.01	91.4	60.2	(72.1, 110.7)	10	0.01	85.5	70	(71.2, 99.8)
Cheese	25.3	0.02	38.6	33.3	(34.3, 42.8)	25.8	0.02	37.6	30	(32.4, 42.8)
Coffee and tea	79.1	0.02	117.3	96.1	(111.0, 123.6)	75.8	0.02	115.8	96.1	(106.1, 125.5)
Cold Cuts	11.5	0.01	41.9	30	(34.3, 49.6)	16.5	0.02	32.5	30	(25.7, 39.3)
Commercial juices	17.5	0.01	306.1	257.1	(278.9, 333.3)	23.6	0.02	281.5	240	(258.2, 304.8)
Eggs	9.1	0.01	57.1	50	(52.0, 62.1)	11.6	0.02	47.6	50	(37.9, 57.3)
Flavored powder	9.8	0.01	31	25	(26.2, 35.8)	8.9	0.02	27.7	22	(20.1, 35.3)
Fried snacks	5.8	0.01	119.7	102	(97.4, 142.0)	5.5	0.01	151.1	130	(114.3, 187.9)
Fruit juices	21	0.02	516.9	251.6	(102.8, 931.0)	21.5	0.02	259.7	240.4	(234.4, 285.0)
Fruits	26.3	0.02	151.1	130	(137.0, 165.2)	34.6	0.03	172	140	(151.5, 192.5)
Leafy Vegetables	41	0.02	40.4	30	(35.3, 45.5)	43	0.02	43	32	(37.4, 48.6)
Milk	61.7	0.02	165.7	136.1	(155.5, 175.9)	55.7	0.03	150.2	123.8	(139.1, 161.2)
Pasta	19.6	0.02	237.6	245	(212.9, 262.4)	19.6	0.02	219.2	208.8	(198.4, 239.9)
Pizza	8.1	0.01	300.1	286.4	(249.7, 350.6)	8.1	0.01	209.6	200.3	(180.9, 238.2)
Red meat	58.9	0.02	117.2	100	(110.6, 123.7)	59.9	0.02	116.2	100	(104.0, 128.5)
Rice	78.1	0.02	163.4	132.5	(153.6, 173.1)	82.5	0.02	142.3	124	(131.5, 153.1)
Salted snacks	16.9	0.01	95.7	71.3	(78.5, 112.9)	15.6	0.02	90.3	60	(67.0, 113.6)
Sandwiches	4.4	0.01	234.3	202	(194.8, 273.8)	4.3	0.01	157.5	124.9	(106.6, 208.4)
Snacks	2.1	0.01	81	40	.	1.8	0.01	52.8	24	.
Soft drinks	32.7	0.02	346.5	311.4	(318.6, 374.4)	35.5	0.02	313	250	(287.9, 338.1)
Soups	9.4	0.02	431.4	319	(344.3, 518.6)	3.8	0.01	385.9	300	(256.7, 515.1)
Sugar	58.7	0.03	9.8	7.2	(8.83, 10.7)	68.6	0.03	9.4	7.8	(8.55, 10.2)
Sweets	19.7	0.02	90.3	69.7	(81.1, 99.5)	28.7	0.02	82.2	52.5	(70.5, 93.9)
Toast and Biscuits	22.6	0.02	43.4	32	(36.8, 50.0)	25.4	0.02	39	30	(32.1, 45.9)
Tubers and roots	13.7	0.01	112.4	90	(90.5, 134.3)	16.8	0.02	139.6	80	(81.8, 197.4)
Vegetables	45.2	0.02	78.6	60	(69.9, 87.4)	47.2	0.03	80.8	54.3	(63.9, 97.7)
White meat	33.6	0.02	101.7	80	(92.0, 111.4)	41	0.02	121.7	100	(104.5, 139.0)

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^aThe list of foods included in each food grouping is described in Table S1. ^bTrend was estimated using logistic and linear regression models.

Note: missing standard errors because of stratum with single sampling unit.

Table S3 (Cont): Frequency of consumption and portion size of food groupings for adults of the ISA-Nutrition in 2003, 2008 and 2015.

Food Grouping ^a	Total Adults (<i>n</i> = 1865)						
	ISA-Nutrition 2015 (<i>n</i> = 613)						
	Consumption		Portion size (grams)			p ^b	
	%	SE	mean	median	IQR	trend portion	trend freq
Alcoholic beverages	14.5	0.02	739.6	351.5	(530.7, 948.6)	0.853	0.113
Beans	66.1	0.03	111.2	86	(104.0, 118.4)	0.16	0.313
Breads and rolls	74.1	0.02	60.4	50	(57.4, 63.4)	0.638	0.14
Butter and margarine	48.1	0.02	17.4	15	(16.0, 18.7)	0.052	0.942
Cakes	13.7	0.02	94.8	70	(73.2, 116.4)	0.845	0.19
Cheese	25.5	0.02	37.8	30	(33.1, 42.5)	0.79	0.924
Coffee and tea	76.5	0.02	154.4	133.1	(140.3, 168.6)	0	0.276
Cold Cuts	12.9	0.01	30.7	20	(23.6, 37.8)	0.03	0.283
Commercial juices	28.5	0.02	296	240	(260.6, 331.3)	0.648	0
Eggs	12.2	0.02	74.9	50	(62.2, 87.6)	0.016	0.101
Flavored powder	8.5	0.01	24.2	22	(20.7, 27.7)	0.035	0.446
Fried snacks	4.9	0.01	103.5	100	(84.5, 122.4)	0.619	0.578
Fruit juices	23.4	0.02	309.3	251.6	(281.6, 337.0)	0.31	0.401
Fruits	42.7	0.02	157.2	130	(142.4, 172.0)	0.546	0
Leafy Vegetables	44	0.02	37.5	30	(33.4, 41.7)	0.504	0.384
Milk	56.9	0.03	158.7	148.5	(148.2, 169.2)	0.229	0.094
Pasta	19.8	0.02	192.9	165	(152.3, 233.4)	0.06	0.946
Pizza	8.5	0.01	282.1	295.2	(236.9, 327.2)	0.389	0.848
Red meat	58.2	0.02	109.3	100	(100.2, 118.3)	0.187	0.884
Rice	80.6	0.02	155.9	132.5	(145.7, 166.1)	0.164	0.319
Salted snacks	16.8	0.02	125.5	119.8	(107.3, 143.8)	0.039	0.924
Sandwiches	4.1	0.01	163.3	158	(127.8, 198.7)	0.009	0.815
Snacks	2.6	0.01	61.7	50	.	.	.
Soft drinks	32.6	0.02	335.1	290	(306.7, 363.4)	0.433	0.918
Soups	7.2	0.01	382	389.7	(309.3, 454.8)	0.376	0.227
Sugar	60.8	0.03	11.1	8.6	(9.86, 12.4)	0.133	0.376
Sweets	32.7	0.02	71.5	47.5	(58.7, 84.3)	0.02	0
Toast and Biscuits	26.3	0.02	52.2	30	(43.0, 61.4)	0.17	0.129
Tubers and roots	15.4	0.02	145.5	88.7	(111.3, 179.7)	0.093	0.352
Vegetables	48.5	0.03	72.8	54.6	(64.0, 81.7)	0.429	0.283
White meat	38.3	0.02	118.2	100	(107.7, 128.7)	0.016	0.073

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^a The list of foods included in each food grouping is described in Table S1. ^b Trend was estimated using logistic and linear regression models.

Note: missing standard errors because of stratum with single sampling unit.

Table S4: Frequency of consumption and portion size of food groupings for older adults of the ISA-Nutrition in 2003, 2008 and 2015.

Food Grouping ^a	Total Older Adults (<i>n</i> = 1143)									
	ISA-Nutrition 2003 (<i>n</i> = 456)					ISA-Nutrition 2008 (<i>n</i> = 321)				
	Consumption		Portion size (grams)			Consumption		Portion size (grams)		
	%	SE	mean	median	IQR	%	SE	mean	median	IQR
Alcoholic beverages	7.5	0.01	401.6	301.3	(272.9, 530.3)	6.5	0.01	317.2	351.5	(243.3, 391.0)
Beans	63	0.02	85.6	81.9	(78.9, 92.2)	67.3	0.03	87.1	86	(81.1, 93.0)
Breads and rolls	74.8	0.02	50.6	50	(48.6, 52.6)	78.1	0.02	51.5	50	(48.8, 54.2)
Butter and margarine	44.2	0.02	13.2	7.5	(12.1, 14.3)	46	0.02	15.7	15	(14.2, 17.1)
Cakes	5.8	0.01	83.8	60.2	(65.9, 101.7)	9.6	0.02	73.2	60	(60.6, 85.7)
Cheese	30	0.02	37.7	30	(32.9, 42.4)	30.4	0.02	36.4	30	(31.8, 41.0)
Coffee and tea	91.7	0.01	113.2	96.1	(105.8, 120.7)	88.4	0.01	108.7	96.1	(103.6, 113.9)
Cold Cuts	7.8	0.01	31.8	30	(25.7, 38.0)	10.8	0.02	36.3	30	(25.2, 47.5)
Commercial juices	7.5	0.01	319.4	240.3	(131.2, 507.7)	15.3	0.02	225.9	240	(192.8, 258.9)
Eggs	8.5	0.01	54.4	50	(48.2, 60.6)	11.8	0.01	46.8	50	(38.5, 55.0)
Flavored powder	4.1	0.01	41	25	(19.2, 62.8)	4.6	0.01	19.6	12.5	(9.68, 29.5)
Fried snacks	2.8	0.01	114.5	100	(82.7, 146.4)	3.2	0.01	81.4	50	(41.4, 121.5)
Fruit juices	14.8	0.01	227.1	240.4	(206.1, 248.0)	13.9	0.02	260	240.3	(210.3, 309.6)
Fruits	54.4	0.03	181.4	155	(166.2, 196.5)	58.4	0.03	187.6	158.2	(170.2, 205.0)
Leafy Vegetables	49.4	0.02	45.7	35	(39.8, 51.5)	47.9	0.02	42	35	(36.7, 47.3)
Milk	72.9	0.02	156.5	140.3	(147.5, 165.5)	79.1	0.02	141.2	124.3	(133.7, 148.7)
Pasta	18	0.02	244.6	199.8	(187.4, 301.8)	14.9	0.02	178.6	135	(140.4, 216.7)
Pizza	3.1	0.01	301.1	286.5	.	2.6	0.01	167.4	113.2	.
Red meat	50.8	0.02	93.3	90	(87.5, 99.1)	56.8	0.02	95.2	80	(83.1, 107.3)
Rice	79.2	0.03	135.1	106	(127.3, 142.9)	80.4	0.03	126.7	112.5	(116.6, 136.8)
Salted snacks	10.5	0.02	76.6	50	(61.8, 91.4)	7.9	0.02	83.8	60	(51.0, 116.6)
Sandwiches	0.6	0	137.6	118	.	0.5	0	118.8	85.5	.
Snacks	0.6	0	41.6	50	.	0.6	0	87.7	50	.
Soft drinks	15.3	0.01	246.6	240.2	(214.3, 278.8)	19.4	0.02	227.5	222.2	(202.9, 252.0)
Soups	16	0.02	356	325	(312.0, 400.1)	15.4	0.02	383.3	325	(320.7, 445.8)
Sugar	54.3	0.02	9	7.5	(7.97, 9.95)	57.8	0.02	10.2	7.8	(8.75, 11.6)
Sweets	15.8	0.02	81.9	60.5	(65.3, 98.6)	17.4	0.02	68.8	50	(54.2, 83.3)
Toast and Biscuits	27.8	0.02	28.6	24	(26.2, 31.0)	25.6	0.02	26	24	(23.0, 28.9)
Tubers and roots	15.2	0.02	116.4	90	(96.7, 136.2)	16.9	0.02	105.4	80	(83.0, 127.7)
Vegetables	45.9	0.03	76.2	60	(68.4, 84.0)	50	0.02	82.6	50	(69.2, 96.0)
White meat	31.4	0.02	101.3	80	(90.0, 112.6)	31.8	0.02	94.5	80	(83.1, 105.9)

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^a The list of foods included in each food grouping is described in Table S1. ^b Trend was estimated using logistic and linear regression models.

Note: missing standard errors because of stratum with single sampling unit.

Table S4 (Cont): Frequency of consumption and portion size of food groupings for older adults of the ISA-Nutrition in 2003, 2008 and 2015.

Food Grouping ^a	Total Older Adults (<i>n</i> = 1143)						
	ISA-Nutrition 2015 (<i>n</i> = 366)					<i>p</i> ^b	
	Consumption	Portion size (grams)					
	%	SE	mean	median	IQR	trend portion	trend freq
Alcoholic beverages	10.9	0.01	498.2	304.0	(300.4, 695.0)	0.346	0.038
Beans	65.0	0.03	89.7	79.0	(83.2, 96.3)	0.374	0.646
Breads and rolls	82.8	0.02	49.2	50.0	(46.7, 51.7)	0.346	0.004
Butter and margarine	50.1	0.03	15.7	15.0	(14.5, 16.9)	0.005	0.087
Cakes	9.2	0.01	77.2	60.0	(58.7, 95.6)	0.715	0.090
Cheese	35.2	0.03	33.1	30.0	(29.9, 36.3)	0.104	0.144
Coffee and tea	92.1	0.02	123.1	101.8	(114.5, 131.6)	0.067	0.712
Cold Cuts	9.1	0.02	23.8	17.0	(19.2, 28.4)	0.019	0.575
Commercial juices	15.1	0.02	203.1	200.0	(174.9, 231.3)	0.193	0.001
Eggs	10.1	0.01	55.7	50.0	(47.7, 63.6)	0.632	0.478
Flavored powder	4.6	0.01	24.3	16.0	(16.1, 32.6)	0.177	0.746
Fried snacks	3.8	0.01	79.8	65.0	(61.1, 98.6)	0.084	0.425
Fruit juices	18.9	0.02	221.5	211.3	(195.9, 247.0)	0.559	0.079
Fruits	66.0	0.03	155.1	131.4	(143.2, 166.9)	0.003	0.002
Leafy Vegetables	51.1	0.03	37.3	30.0	(32.9, 41.8)	0.025	0.599
Milk	72.0	0.02	146.7	128.9	(136.7, 156.7)	0.201	0.622
Pasta	16.0	0.02	169.8	150.0	(145.8, 193.8)	0.020	0.500
Pizza	3.3	0.01	355.4	362.6	.	.	.
Red meat	55.0	0.02	94.2	80.0	(87.1, 101.3)	0.881	0.273
Rice	83.1	0.02	124.8	108.5	(116.3, 133.2)	0.089	0.199
Salted snacks	9.1	0.01	90.5	65.0	(60.4, 120.6)	0.420	0.600
Sandwiches	1.3	0.01	148.3	185.3	.	.	.
Snacks	0.6	0.00	17.9	10.0	.	.	0.922
Soft drinks	17.6	0.02	261.8	216.0	(228.2, 295.4)	0.424	0.339
Soups	12.4	0.02	398.3	466.0	(327.9, 468.7)	0.319	0.241
Sugar	52.0	0.03	9.4	8.0	(8.30, 10.6)	0.608	0.451
Sweets	26.7	0.03	73.7	50.0	(61.2, 86.1)	0.533	0.001
Toast and Biscuits	25.6	0.02	25.9	24.0	(22.5, 29.4)	0.227	0.504
Tubers and roots	19.7	0.02	130.2	63.9	(89.9, 170.6)	0.488	0.069
Vegetables	56.4	0.03	73.3	54.0	(62.9, 83.6)	0.557	0.010
White meat	38.2	0.03	107.1	95.0	(94.9, 119.3)	0.406	0.039

Abbreviations: SE, Standard Error; IQR, Interquartile Range. ^aThe list of foods included in each food grouping is described in Table S1. ^bTrend was estimated using logistic and linear regression models.

Note: missing standard errors because of stratum with single sampling unit.

5.3 TERCEIRO MANUSCRITO

Diet quality, excess body weight, and cardiometabolic risk factors in adolescents living in São Paulo, Brazil and in the USA – differences and similarities*Jaqueline Lopes Pereira¹**Regina Mara Fisberg¹**Carmen R. Isasi²**Linda Van Horn³**Mercedes Carnethon³**Martha Daviglus³**Marisa J. Perera⁴**Daniela Sotres-Alvarez⁵**Josiemer Mattei⁶*

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Keywords: diet quality, obesity, overweight, adolescents

5.3.1 ABSTRACT

Background/Objective: Differences in culture and food environments may influence dietary intake. We aimed to compare diet quality and its association with excess body weight (EBW: overweight and obesity), central adiposity (CA), and cardiovascular disease risk factors (CVDR) among adolescents from Brazil and USA.

Subjects/Methods: Cross-sectional data from adolescents (12-16y) was analyzed from the Health Survey of São Paulo (ISA-Nutrition; n=189), and the Hispanic Community Health Study/Study of Latino Youth (SOL-Youth; n=787). EBW was defined using World Obesity Federation cutoffs; CA as waist circumference > 90th sex- and age-specific percentile; and CVDR as ≥ 3 conditions of: obesity, high blood pressure, dyslipidemia, high plasma glucose or hemoglobin A1c, or insulin resistance. Diet was assessed by two 24-hour recalls. Diet quality was defined using the Alternate Healthy Eating Index-2010 (AHEI) and the Revised Brazilian Healthy Eating Index (BHEI-R). Adjusted odds ratios (95% CI) for EBW, CA, and CVDR by diet quality index were tested using logistic regression models.

Results: Prevalence (95% CI) of EBW, CA, and CVDR was 28.7% (21.7, 35.7), 6.5% (2.9, 10.1), and 18.8% (12.9, 24.7) in ISA-Nutrition and 42.5% (37.5, 47.5), 12.6% (9.5, 15.6), and 17.2% (14.2, 20.3) in SOL-Youth. ISA-Nutrition participants with EBW (vs. without) had marginally lower (unhealthier) scores for whole grains using BHEI-R and sugary beverages using AHEI. SOL-Youth participants with EBW had lower scores of nuts and legumes using AHEI, and sodium using BHEI-R, but higher scores of whole grains and dairy using BHEI-R. In ISA-Nutrition, BHEI-R was inversely associated with EBW (0.87; 0.80, 0.95) and CVDR (0.89; 0.80, 0.98). In SOL-Youth, AHEI was inversely associated with EBW (0.93; 0.87, 0.99).

Conclusions: When using diet quality indices originally defined for each population, healthier diet quality was associated with lower odds of EBW in Brazilian and USA-Hispanic/Latino adolescents, and with lower CVDR in Brazilian adolescents.

5.3.2 Introduction

In the last decades, the prevalence of excess body weight (EBW: overweight and obesity) in children and adolescents has rapidly increased worldwide (WHO, 2016). Specifically in Latin America, children and adolescents are disproportionately affected by the obesity epidemic (WHO, 2016; NG et al., 2013). In 2013, the highest prevalence of EBW was observed in Chile (37%), Uruguay (31.2%) and Mexico (28.4%) among boys, and in Costa Rica (37.7%), Uruguay (37.7%) and Chile (31.6%) among girls (NG et al., 2013). In Brazil, the prevalence of EBW was 22.1% in boys and 24.3% in girls in 2013 (NG et al., 2013). In comparison, in the USA, the prevalence of EBW among children and adolescents was 28.8% in boys and 29.7% in girls (NG et al., 2013).

Notably, there are differences in the prevalence of obesity according to several factors, such as socioeconomic status and race/ethnicity (WHO, 2016). In 2014, the prevalence of EBW in USA among white youth aged 2 to 19 years was 27.5% for girls and 31.4% for boys, while the prevalence among Hispanics was 42.4% for girls and 41.3% for boys (SKINNER et al., 2016). Additionally, the prevalence of obesity among high-socioeconomic status adolescents has recently decreased, whereas it has continued to increase among their low-socioeconomic status peers (FREDERICK et al., 2014).

The high prevalence of pediatric obesity, especially in low-income and racial/ethnic subgroups, is a public health issue because adolescents with EBW are more susceptible to several health problems, including dyslipidemia, hypertension, insulin resistance, and metabolic syndrome as well as cardiovascular disease (WHO, 2016; REILLY and KELLY, 2011). As a consequence, besides the individual health

effects, EBW also causes a significant increase in direct and indirect health expenditures, becoming a problem for the economy and the health systems (WITHROW e ALTER, 2011).

Adolescence is an especially important critical period regarding nutritional status because of the high energy and nutrient demand needed for physical growth and development, the changes in lifestyle and habits that affect food consumption, the likelihood of establishing lifelong dietary habits, and the direct influence of dietary intake in adolescence on adulthood cardiometabolic health and obesity (LIEN et al., 2001; STORY et al., 2002; MIKKILA et al., 2007; DAHM et al., 2016). Despite the importance of diet quality in this life stage, studies indicate the marked presence of inadequate dietary intake in this population, such as high consumption of foods with high energy density and low nutritional value, and low consumption of fruits and vegetables, characterizing a low diet quality, rich in fat, sugar, cholesterol and low in fiber and some vitamins and minerals such as calcium, phosphorus, and vitamins A, D and C (MOURA SOUZA et al., 2013; MORENO et al., 2010; ANDRADE et al., 2010; LEVY et al., 2009).

Differences in culture and food environment between populations may influence food choices and, consequently, affect dietary aspects involved in the etiology of EBW and cardiometabolic risk factors (WHO, 2016; CUTLER et al., 2011; BOOTH et al., 2001). Identifying differences and similarities in diet quality and its association with these aspects in adolescents living in Brazil and in the USA – two countries with documented high prevalence of EBW – may contribute to advancing the current knowledge about these relations, especially because this has not been well established in adolescents (FUNTIKOVA et al., 2015; MARSHALL et

al., 2014). Some studies suggest that healthy food consumption patterns during adolescence may prevent accumulation of cardiometabolic risk, but further validation in diverse populations should be done (MOORE et al, 2016; SHANG et al., 2012).

In this context, we aimed to compare diet quality and its association with excess body weight (EBW), central adiposity (CA), and cardiovascular disease risk factors (CVDR) among Brazilian adolescents living in São Paulo, Brazil and Hispanic/Latino adolescents living in USA.

5.3.3 Methods

Study Design and Population

This research compared data from two studies: the Health Survey of São Paulo with Focus in Nutrition Study (ISA-Nutrition) and the Hispanic Community Children's Health Study/Study of Latino Youth (SOL-Youth). Parents and children provided written consent or assent in both studies, which were approved by the respective ethics committee: Ethics Committee on Research of the Public Health School, University of São Paulo for 2015 ISA-Nutrition, and the institutional review boards at each field center for SOL-Youth.

The ISA-Nutrition is a sub-sample of the Health Survey of São Paulo (ISA-Capital), a cross-sectional, population-based study with a probabilistic sample of individuals aged 12 years and older living in households in the urban area of the city of São Paulo (ALVES et al., 2018). The study aimed to evaluate the health status and the use of health services of São Paulo population. In ISA-Capital, the collection of information on socioeconomic and demographic data, self-reported morbidity, use of medications and nutritional supplements, health services, as well as lifestyle (eating

habits, physical activity, sleep, smoking, and alcohol consumption) were carried out in the households, using a structured questionnaire applied by trained interviewers throughout the year of 2015 in 4,024 individuals, of which 859 were adolescents (aged 12-19 years). In ISA-Nutrition, anthropometric data, blood pressure measurements, and blood samples were collected in a subsample of the ISA-Capital population (adolescents n=290) during a second visit to the participant's home. Dietary intake was assessed by two 24-hour dietary recalls (24HR). The first 24HR was collected in the households and the second one by telephone. Details of the study and its sampling design are published elsewhere (FISBERG et al., 2018).

The population source for SOL-Youth is a population-based sample with the offspring of Hispanic/Latino households whose adult members were enrolled in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). HCHS/SOL is a population-based cohort study of 16,415 Latino adults (ages 18–74 years) who were selected using probability sampling from four US cities (Chicago, IL; Miami, FL; Bronx, NY; San Diego, CA) with baseline data collection carried out between 2008 and 2011. The aims of HCHS/SOL are to determine the role of acculturation in the prevalence and development of disease, and to identify risk factors playing a protective or harmful role in Hispanics/Latinos. Children aged 8 to 16 years at the time of the baseline examination living with at least one parent or legal guardian who participated in HCHS/SOL were invited to participate for SOL-Youth. Data collection occurred between 2012-2014 in a total of 1,600 participants. The SOL Youth aimed to investigate the influence of youth acculturation and parent-child differences in acculturation; the influence of youth's psychosocial functioning; and the associations of parent behaviors on youth's behaviors and cardiometabolic risk

profiles. The collection of socioeconomic and demographic data and clinic examination were obtained during a baseline visit to one of the field centers, and two 24HR were completed on the telephone. Details of the study and its sampling design are published elsewhere (ISASI et al., 2014).

For comparison between studies, data from both studies was restricted to individuals aged 12 to 16 years old, with complete dietary, anthropometric, and sociodemographic information. Also, those with extreme values of energy intake ($<1^{\text{st}}$ and $>99^{\text{th}}$ sex-specific percentile for each 24HR) were excluded (MATTEI et al., 2016). The final sample for this analysis was 189 adolescents for ISA-Nutrition and 787 adolescents for SOL-Youth.

Excess body weight and cardiometabolic risk factors

Excess body weight was defined as having overweight or obesity, according to the sex- and age-specific World Obesity Federation cutoffs, which are internationally-based, since the reference population was obtained by averaging across a heterogeneous mix of surveys from different countries, including USA and Brazil (COLE et al., 2000). Central adiposity (CA) was defined as waist circumference $> 90^{\text{th}}$ percentile, specific for sex and age; and cardiovascular disease risk factors (CVDR) was categorized as having three or more of the following conditions: obesity (World Obesity Federation cutoffs), high systolic or diastolic blood pressure ($\geq 90^{\text{th}}$ percentile for sex, age, and height) (NATIONAL HIGH BP, 2004), dyslipidemia (total cholesterol ≥ 200 mg/dL, or LDL-C ≥ 130 mg/dL, or HDL-C ≤ 40 mg/dl, or triglycerides ≥ 150 mg/dL) (EXPERT PANEL, 2011), high fasting plasma glucose (≥ 100 mg/dL) or hemoglobin A1c (≥ 5.7 mg/dL), or insulin resistance (HOMA_IR ≥ 2.5) (ADA, 2015). The description of how laboratory

measurements were performed in both studies are published elsewhere (FISBERG et al., 2018; ISASI et al., 2016).

The Homeostatic Assessment of Insulin Resistance (HOMA-IR) was defined as: $\text{Fasting Glucose (mg/dL)} \times \text{Fasting Insulin } (\mu\text{U/L}) / 405$ (MATTHEWS et al., 1985). Due to the lack of consensus in literature, we presented the metabolic syndrome variable following two definitions. The first was the *Adult Treatment Panel III* (ATP III) of the *National Cholesterol Education Programme* (NCEP) (GRUNDY et al., 2004), where the adolescent is considered with metabolic syndrome when presenting three or more of the following conditions: high blood pressure (systolic or diastolic), high triglycerides, low HDL-c, high fasting glycemia, type 2 diabetes, and central obesity (STEINBERGER et al., 2009). The second definition is from the *International Diabetes Federation* (IDF), in which the adolescent is considered with metabolic syndrome when he or she has central obesity (independent of the other components) and the presence of two or more other clinical features (high triglycerides, low HDL-c, high systolic or diastolic blood pressure, high fasting blood glucose) (ALBERTI et al., 2006).

Dietary information

In both studies, dietary intake was assessed by two 24HR, collected by trained interviewers, representing all days of the week, and season of the year, using the procedures of the Multiple Pass Method - MPM (MOSHFEHGH et al., 2008). Food consumption data were entered in the Nutrition Data System for Research (NDSR) software (version 2014), developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, United States of America, which uses the food composition table developed by the United States Department of Agriculture as main

data source. The nutritional values of energy and macronutrients of each food included in the 2015 ISA-Nutrition database were compared to those in Brazilian food composition tables (TBCA - USP, 2017; TACO - Unicamp, 2004), and when the values differed between the databases, they were corrected to correspond to those of the foods consumed by the population of São Paulo. In both ISA-Nutrition and SOL-Youth studies, a comprehensive database with the nutritional values of regional and cultural foods and preparations were developed with a rich set of standardized recipes and food formulations.

The NCI method, which accounts for within- and between-person variance components and corrects for the high intraindividual variation intrinsic to 24HR, was used to estimate the usual intake of each analyzed nutrient and food group (TOOZE et al., 2010).

Diet quality was defined using the Alternate Healthy Eating Index-2010 (AHEI) (MCCULLOUGH et al, 2002; CHIUVE et al., 2012) and the Brazilian Healthy Eating Index Revised (BHEI-R) (PREVIDELLI et al., 2011). For both indexes, the maximum score is 100, which indicates the highest diet quality. The original AHEI-2010 maximum score is 110, however the component of alcohol was excluded from the index, since the consumption of alcohol is not allowed to this age groups. The components of each healthy eating index are described in **Chart 1**.

Chart 1: Components of the Brazilian Healthy Eating Index Revised (BHEI-R) and the Alternate Healthy Eating Index 2010 (AHEI).

Brazilian Healthy Eating Index Revised (BHEI-R)	Alternate Healthy Eating Index 2010 (AHEI)
Total fruit	Vegetables without potatoes
Whole fruit	Whole Fruit
Total vegetable	Whole grains
Dark-green/orange vegetables and legumes	Sugar sweetened beverages and fruit juice
Total grains	Nuts and legumes
Whole grains	Red and processed meat
Milk and dairy	Trans Fat
Meats, eggs and Legumes	Long-chain (n-3) fats (EPA+DHA)
Vegetable Oils, Seed Oils and Oily Fish	Polyunsaturated fatty acids (PUFA)
Saturated fat	Sodium
Sodium	Alcohol
Calories from solid fat and added sugar	

Source: Adapted from Chiuve et al. (2012) and Previdelli et al. (2011).

Statistical Analysis

Categorical variables were described as percentages and 95% confidence intervals, and differences in categorical variables between participants with and without EBW were evaluated using Rao-Scott Chi-Square tests. Usual intake of energy and several nutrients as well as the components and total score for BHEI-R and AHEI were described as means and 95% confidence intervals and the variables were compared using regression analysis adjusted for total energy intake (except for energy and energy density), sex, and age.

Adjusted odds ratios and 95% confidence intervals for EBW, CA, and CVDR according to each diet quality index were tested using logistic regression models, adjusting for confounders. The models for 2015 ISA-Nutrition were adjusted for age, sex, and income. For HCHS/SOL-Youth, they were adjusted for age, sex, income, and Hispanic/Latino background. For both populations, AHEI models were also

adjusted for total energy intake, but not BHEI as it is estimated for 1000 kcal. All analyses used appropriate sample weight and complex survey procedures, performed in SAS, version 9.3. A $p < 0.05$ was considered for statistical significance.

5.3.4 Results

Prevalence of EBW, CA, and CVDR was 29% (95 % CL: 21.7, 35.7 %), 7%, and 19% in ISA-Nutrition and 43% (95 % CL: 37.5, 47.5 %), 13%, and 17% in SOL-Youth. Females had more EBW compared to males in ISA-Nutrition while those with lower total household income had higher EBW in SOL-Youth (Table 1). Comparing the differences between both surveys through the lack of overlap of the 95% confidence intervals, ISA-Nutrition presented higher prevalence of adolescents with lower household income, and with parents or householders married or with partner. They also presented higher prevalence of high systolic blood pressure, low HDL-cholesterol, high triglycerides/HDL-C ratio, and dyslipidemia than adolescents from SOL-Youth.

In both studies, those with EBW presented more cardioalvascular risk factors than those without EBW (Table 1). The prevalence of CA, hypertension, high total cholesterol, low HDL-c, high triglycerides/HDL-c ratio, dyslipidemia, insulin resistance, CVDR and metabolic syndrome was higher among those with EBW in both studies. In addition, the same pattern was observed for high triglycerides in SOL-Youth and for high diastolic BP in ISA-Nutrition.

Table 2 describes the usual energy and nutrient intake by nutritional status in both studies. Adolescents without EBW in ISA-Nutrition presented higher vitamin A intake and marginally higher fiber and potassium intake than those with EBW. In SOL-Youth, those without EBW had higher energy and energy density intake and

lower total grams of food and beverages, protein, omega-3 fats, cholesterol, sodium, phosphorus, and zinc than those with EBW. Several differences in dietary intake were observed between surveys: adolescents from ISA-Nutrition consumed more energy, total grams, protein (g/d), carbohydrates (g/d), total fat (g/d and % kcal), trans and polyunsaturated fatty acids, total fiber, sodium, iron, and zinc than those from SOL-Youth study, who consumed more carbohydrates (% kcal), saturated and omega-3 fatty acids, total and added sugars, calcium, phosphorus, and vitamins D and C.

Table 1: Characteristics of adolescents in ISA-Nutrition and in the HCHS/SOL-Youth studies according to nutritional status^a

		2015 ISA-Nutrition						
		Total adolescents (n=189)		Without EBW (n=135) ^b		With EBW (n=54) ^b		
		%	95% CL	%	95% CL	%	95% CL	p ^c
<i>Age group</i>	12 -- 14 years old	38.1	(30.3, 45.9)	37.6	(28.8, 46.4)	39.3	(24.4, 54.2)	0.8396
	14 -- 16 years old	61.9	(54.1, 69.7)	62.4	(53.6, 71.2)	60.7	(45.8, 75.6)	
<i>Sex (Females)</i>		52.8	(45.2, 60.3)	47.1	(38.4, 55.8)	66.8	(51.7, 82.0)	0.0344
<i>Education parent</i>	Less than High School	47.8	(38.5, 57.1)	50.5	(40.2, 60.7)	41.2	(25.8, 56.7)	0.6130
	High School/Equiv.	29.6	(21.6, 37.5)	27.8	(19.3, 36.3)	33.9	(17.3, 50.6)	
	More than High School	22.6	(14.8, 30.4)	21.7	(13.3, 30.2)	24.8	(9.35, 40.3)	
<i>Total Income</i>	Less than/equal to \$15000	82.0	(73.2, 90.9)	79.7	(69.5, 89.9)	87.9	(76.7, 99.1)	0.2382
<i>Household income adjusted^d</i>	1st tertile	33.1	(24.1, 42.1)	34.8	(25.5, 44.0)	28.7	(13.0, 44.4)	0.1148
	2nd tertile	30.8	(21.8, 39.7)	26.2	(16.9, 35.5)	42.3	(27.4, 57.2)	
	3rd tertile	36.2	(26.8, 45.6)	39.0	(28.5, 49.6)	29.0	(14.5, 43.5)	
<i>Parent/householder marital status</i>	Single	4.60	(0.33, 8.85)	3.94	(0, 8.65)	6.19	(0, 15.0)	0.8638
	Married/Partner	78.9	(71.6, 86.2)	79.1	(69.7, 88.4)	78.6	(65.6, 91.7)	
	Divorced/Widowed	16.5	(9.70, 23.2)	17.0	(8.04, 25.9)	15.2	(4.0, 26.4)	
<i>Cardiovascular risk factors</i>								
Central Adiposity (waist circ.>=90%ile)		6.50	(2.94, 10.1)	0.85	(0, 2.56)	20.3	(9.71, 30.8)	<.0001
Systolic BP >=90%ile		11.4	(5.57, 17.3)	8.86	(3.73, 14.0)	17.8	(4.51, 31.0)	0.1025
Diastolic BP >=90%ile		8.80	(3.45, 14.1)	4.07	(0.21, 7.92)	20.6	(6.25, 34.9)	0.0015
<i>Hypertension</i>	Prehypertensive (90-94%ile)	5.38	(1.22, 9.53)	3.80	(0.45, 7.16)	9.29	(0, 21.5)	0.0163
	Hypertensive (>=95%ile)	10.2	(4.28, 16.1)	6.26	(1.76, 10.8)	20.0	(6.68, 33.2)	
Total cholesterol >= 200 mg/dL		5.20	(1.90, 8.49)	2.91	(0.22, 5.61)	11.0	(1.25, 20.7)	0.0339
HDL-C <=40 mg/dL		41.0	(33.1, 48.9)	34.9	(26.2, 43.7)	56.3	(43.4, 69.2)	0.0031
LDL-C >= 130 mg/dL		3.64	(0.97, 6.31)	2.65	(0, 5.63)	6.17	(0.10, 12.2)	0.2584
Triglycerides >=150 mg/dL		5.91	(2.10, 9.72)	4.26	(0.26, 8.26)	10.1	(1.40, 18.7)	0.1644
Triglycerides/HDL-C ratio >=2.2		32.6	(25.8, 39.4)	22.6	(14.8, 30.3)	57.9	(43.1, 72.7)	<.0001
Dyslipidemia (yes)		44.9	(37.2, 52.6)	37.8	(28.7, 47.0)	62.7	(50.0, 75.5)	0.0020
Fasting glucose >100		10.5	(5.57, 15.5)	9.69	(3.84, 15.5)	12.7	(2.37, 22.9)	0.6096
Fasting glucose >126		0.56	(0, 1.67)	0.78	(0, 2.33)	-	-	-
Impaired fasting glucose (yes)		10.5	(5.57, 15.5)	9.69	(3.84, 15.5)	12.7	(2.37, 22.9)	0.6096
Insulin Resistance (HOMA_IR >= 2.5)		60.3	(51.7, 69.0)	48.4	(38.2, 58.6)	90.2	(79.4, 100)	<.0001
CVD Risk Factors Count (3 or more)		18.8	(12.9, 24.7)	7.06	(2.91, 11.2)	48.1	(33.4, 62.9)	<.0001
Metabolic Syndrome - ATP-III (yes)		3.20	(0.71, 5.69)	1.49	(0, 3.39)	7.44	(0.39, 14.5)	0.0235
Metabolic Syndrome - IDF (yes)		2.21	(0, 4.50)	0.66	(0, 1.97)	5.98	(0.60, 11.4)	0.0007

Abbreviations: EBW, Excess body weight (includes overweight and obesity); 95% C.L., 95% Confidence Limits. ^aAll the analyses take into account the sampling design of each survey. ^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obesity. ^cVariables compared using Rao-Scott Chi-Square tests. ^dValues are per year. For HSP-2015 the medians for each tertile were US\$791, US\$1798, and US\$3525 and for HCHS/SOL-Youth they were US\$2500, US\$4583, and US\$9000, respectively. In Brazil, R\$1 = US\$3.3366 in 2015.

Table 1 (Cont): Characteristics of adolescents in ISA-Nutrition and in the HCHS/SOL-Youth studies according to nutritional status^a

		HCHS/SOL-Youth						
		Total adolescents (n=787)		Without EBW (n=426) ^b		With EBW (n=361) ^b		
		%	95% CL	%	95% CL	%	95% CL	p ^c
Age group	12 -- 14 years old	38.6	(34.5, 42.6)	38.3	(32.9, 43.8)	38.9	(32.7, 45.1)	0.8891
	14 -- 16 years old	61.4	(57.4, 65.5)	61.7	(56.2, 67.1)	61.1	(54.9, 67.3)	
Sex (Females)		48.8	(44.3, 53.4)	48.9	(42.7, 55.2)	48.7	(41.4, 56.0)	0.9699
Ethnic background	Dominican	13.2	(9.61, 16.7)	11.8	(6.80, 16.8)	15.1	(10.1, 20.1)	0.7869
	Puerto Rican	9.71	(6.47, 13.0)	9.84	(5.56, 14.1)	9.53	(5.81, 13.3)	
	Cuban	6.62	(4.39, 8.85)	7.55	(4.47, 10.6)	5.33	(2.20, 8.47)	
	Central American	5.71	(3.74, 7.67)	6.42	(3.38, 9.45)	4.73	(2.68, 6.78)	
	Mexican/Mexican American	48.2	(42.2, 54.1)	47.0	(39.3, 54.7)	49.7	(42.4, 57.1)	
	South American	4.00	(2.23, 5.77)	4.01	(1.65, 6.36)	3.99	(1.55, 6.44)	
	Mixed Hispanic	11.2	(7.47, 14.7)	12.3	(7.01, 17.5)	9.63	(5.91, 13.4)	
	Other	1.48	(0.29, 2.67)	1.13	(0, 2.33)	1.96	(0, 4.14)	
	Education parent	Less than High School	39.1	(33.7, 44.6)	34.3	(27.0, 41.6)	45.7	
	High School/Equiv.	28.5	(23.4, 33.6)	30.2	(23.9, 36.6)	26.1	(18.9, 33.3)	
	More than High School	32.4	(26.9, 37.8)	35.5	(27.8, 43.1)	28.2	(21.9, 34.5)	
Total Income	Less than/equal to \$15000	36.0	(30.4, 41.6)	30.4	(23.5, 37.2)	43.6	(36.1, 51.2)	0.0043
Household income adjusted ^d	1st tertile	32.3	(26.7, 37.9)	28.3	(21.0, 35.6)	37.9	(30.8, 45.0)	0.0851
	2nd tertile	34.1	(28.5, 39.8)	34.5	(27.2, 41.9)	33.6	(26.2, 40.9)	
	3rd tertile	33.6	(28.4, 38.8)	37.2	(29.5, 44.8)	28.6	(22.7, 34.5)	
Parent/householder marital status	Single	14.9	(11.0, 18.8)	15.2	(9.79, 20.6)	14.5	(8.64, 20.4)	0.9638
	Married/Partner	66.6	(61.5, 71.7)	66.0	(58.8, 73.1)	67.4	(60.6, 74.2)	
	Divorced/Widowed	18.5	(14.3, 22.7)	18.8	(12.8, 24.9)	18.1	(12.6, 23.5)	
Cardiovascular risk factors								
	Central Adiposity (waist circ.>=90%ile)	12.6	(9.49, 15.6)	0.13	(0, 0.38)	29.4	(23.3, 35.5)	<.0001
	Systolic BP >=90%ile	3.39	(1.57, 5.21)	2.24	(0, 4.50)	4.95	(1.70, 8.20)	0.1989
	Diastolic BP >=90%ile	2.22	(0.67, 3.76)	2.84	(0.53, 5.15)	1.37	(0.16, 2.59)	0.1582
Hypertension	Prehypertensive (90-94%ile)	2.40	(0.91, 3.90)	1.07	(0, 2.22)	4.21	(1.01, 7.41)	0.0370
	Hypertensive (>=95%ile)	2.69	(0.96, 4.42)	3.47	(0.61, 6.33)	1.64	(0.36, 2.92)	
	Total cholesterol >= 200 mg/dL	4.46	(2.81, 6.12)	1.97	(0.70, 3.23)	7.79	(4.50, 11.1)	
	HDL-C <=40 mg/dL	13.8	(10.9, 16.7)	5.44	(3.27, 7.60)	24.9	(18.8, 31.1)	<.0001
	LDL-C >= 130 mg/dL	3.32	(1.89, 4.74)	1.76	(0.53, 2.99)	5.43	(2.59, 8.27)	0.0066
	Triglycerides >=150 mg/dL	8.33	(5.45, 11.2)	2.16	(0, 4.47)	16.6	(10.6, 22.5)	<.0001
	Triglycerides/HDL-C ratio >=2.2	22.2	(18.5, 25.8)	8.38	(4.82, 11.9)	40.5	(33.7, 47.3)	<.0001
	Dyslipidemia (yes)	21.0	(17.6, 24.5)	9.40	(5.95, 12.9)	36.6	(30.1, 43.0)	<.0001
	Fasting glucose >100	9.33	(6.90, 11.8)	8.79	(5.39, 12.2)	10.1	(6.78, 13.3)	0.5956
	Fasting glucose >126	0.28	(0, 0.84)	-	-	0.66	(0, 1.94)	-
	Impaired fasting glucose (yes)	9.37	(6.90, 11.8)	8.49	(5.17, 11.8)	10.6	(7.10, 14.0)	0.3857
Insulin Resistance (HOMA_IR >= 2.5)		58.8	(54.1, 63.6)	41.4	(35.4, 47.4)	82.3	(77.3, 87.3)	<.0001
CVD Risk Factors Count (3 or more)		17.2	(14.2, 20.3)	2.11	(0.71, 3.50)	37.7	(31.7, 43.7)	<.0001
Metabolic Syndrome - ATP-III (yes)		3.80	(1.95, 5.65)	-	-	8.95	(4.76, 13.1)	-
Metabolic Syndrome - IDF (ves)		4.42	(2.28, 6.55)	-	-	10.4	(5.45, 15.4)	-

Table 2: Dietary variables of adolescents in ISA-Nutrition and in HCHS/SOL-Youth studies according to nutritional status^a

Dietary variables ^c	ISA-Nutrition						
	Total adolescents (n=189)		Without EBW (n=135) ^b		With EBW (n=54) ^b		p ^d
	Mean	95% CL	Mean	95% CL	Mean	95% CL	
Energy (kcal/d)	2004.6	(1956.9, 2052.2)	2013.2	(1951.9, 2074.5)	1983.1	(1903.1, 2063.1)	
Total grams	2308.8	(2246.1, 2371.4)	2302.2	(2227, 2377.4)	2325.1	(2223.2, 2426.9)	0.7132
Energy density (kcal/g)	0.88	(0.85, 0.90)	0.88	(0.85, 0.91)	0.86	(0.82, 0.90)	0.4671
Protein (g/d)	79.1	(77.6, 80.6)	79.4	(77.8, 81.0)	78.4	(75.1, 81.7)	0.5934
Protein (%kcal)	16.2	(16.0, 16.4)	16.3	(16.1, 16.5)	16.1	(15.8, 16.5)	0.5086
Carbohydrates (g/d)	254.1	(251.6, 256.5)	253.9	(251.4, 256.3)	254.6	(249.9, 259.3)	0.7678
Carbohydrates (%kcal)	51.3	(51.1, 51.5)	51.3	(51.1, 51.5)	51.4	(51.2, 51.6)	0.6598
Total Fat (g/d)	72.9	(72.2, 73.6)	72.9	(72.0, 73.8)	73.0	(71.3, 74.7)	0.9112
Total Fat (%kcal)	32.1	(31.9, 32.3)	32.1	(31.9, 32.3)	32.1	(31.8, 32.4)	0.9665
Saturated FA (%kcal)	10.1	(10.0, 10.2)	10.1	(10.0, 10.2)	10.1	(9.97, 10.3)	0.9411
Trans FA (%kcal)	1.29	(1.27, 1.31)	1.30	(1.27, 1.32)	1.28	(1.24, 1.31)	0.3797
PUFA (%kcal)	8.45	(8.38, 8.52)	8.46	(8.36, 8.54)	8.43	(8.29, 8.57)	0.7284
n-3 (EPA+DHA) (g)	42.6	(40.5, 44.7)	42.6	(40.3, 44.8)	42.5	(37.4, 47.6)	0.9743
Total fiber (g/d)	14.3	(13.9, 14.8)	14.6	(14.1, 15.0)	13.8	(13.1, 14.5)	0.0805
Total sugar (%kcal)	18.6	(18.2, 19.1)	18.5	(18.0, 19.0)	18.9	(18.0, 19.9)	0.4302
Added sugar (%kcal)	13.1	(12.9, 13.3)	13.0	(12.8, 13.2)	13.2	(12.7, 13.6)	0.5829
Cholesterol (mg/day)	238.0	(231.2, 244.8)	237.2	(230.7, 243.6)	240.1	(224.6, 255.5)	0.7570
Sodium (mg/day)	3229.9	(3177.0, 3282.7)	3223.7	(3164.4, 3282.9)	3245.3	(3139.5, 3351.1)	0.7377
Calcium (mg/day)	622.9	(604.0, 641.8)	623.2	(601.1, 645.2)	622.2	(590.3, 654.1)	0.9586
Phosphorus (mg/day)	970.1	(955.3, 984.9)	974.6	(956.6, 992.5)	959.0	(929.9, 988)	0.3931
Iron (mg/day)	17.1	(16.9, 17.4)	17.2	(16.8, 17.5)	17.1	(16.7, 17.5)	0.7795
Zinc (mg/day)	11.2	(10.9, 11.5)	11.2	(10.9, 11.5)	11.1	(10.6, 11.7)	0.8113
Potassium (mg/day)	1925.3	(1873, 1977.6)	1955.9	(1891.6, 2020.3)	1849.1	(1751.5, 1946.7)	0.0762
Vitamin A (RAE) (mcg)	583.1	(554.1, 612.1)	600.8	(569.4, 632.1)	539.3	(485.1, 593.5)	0.0406
Vitamin D (mcg/day)	3.33	(3.13, 3.52)	3.28	(3.08, 3.48)	3.44	(3.08, 3.79)	0.4195
Vitamin C (mg/day)	57.8	(55.1, 60.5)	59.0	(55.7, 62.2)	54.9	(49.0, 60.8)	0.2579

Abbreviations: EBW, Excess body weight (includes overweight and obesity); 95%C.L., 95% Confidence Limits; FA, Fatty Acids; PUFA, Polyunsaturated fatty acids. ^aAll the analyses take into account the sampling design of each survey. ^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obese. ^cUsual intake of each dietary variable was estimated using the NCI method (adjusted by gender, age, center, weekend, self-report intake amount - more, same or less than usual amount - and sequence - first or second 24HR). ^dp-values comparing least squares means (LS-means) of fixed effects for the usual intake of each nutrient, adjusted by energy (except for energy and energy density), sex, and age.

Table 2 (Cont): Dietary variables of adolescents in ISA-Nutrition and in HCHS/SOL-Youth studies according to nutritional status^a

	HCHS/SOL-Youth						
	Total adolescents (n=787)		Without EBW (n=426) ^b		With EBW (n=361) ^b		
<i>Dietary variables^c</i>	Mean	95% CL	Mean	95% CL	Mean	95% CL	p ^d
Energy (kcal/d)	1769.1	(1739.4, 1798.8)	1815.4	(1775.7, 1855.2)	1706.5	(1667.4, 1745.5)	0.0003
Total grams	1995.1	(1970.4, 2019.7)	1971.4	(1940.7, 2002.1)	2027.2	(1989.9, 2064.5)	0.0257
Energy density (kcal/g)	0.89	(0.88, 0.90)	0.90	(0.88, 0.92)	0.87	(0.85, 0.88)	0.0020
Protein (g/d)	69.9	(69.2, 70.5)	68.7	(67.9, 69.6)	71.4	(70.6, 72.2)	<.0001
Protein (%kcal)	16.4	(16.3, 16.5)	16.3	(16.1, 16.4)	16.6	(16.5, 16.8)	0.0003
Carbohydrates (g/d)	228.9	(227.3, 230.5)	229.8	(228.0, 231.6)	227.7	(225.2, 230.1)	0.1506
Carbohydrates (%kcal)	52.3	(52.1, 52.5)	52.4	(52.2, 52.7)	52.2	(51.9, 52.4)	0.1622
Total Fat (g/d)	63.3	(62.8, 63.8)	63.2	(62.6, 63.8)	63.4	(62.7, 64.2)	0.6569
Total Fat (%kcal)	31.3	(31.1, 31.5)	31.3	(31.1, 31.6)	31.3	(30.9, 31.6)	0.6401
Saturated FA (%kcal)	11.0	(10.9, 11.1)	11.0	(10.9, 11.1)	10.9	(10.8, 11.1)	0.4538
Trans FA (%kcal)	0.99	(0.98, 1.00)	0.99	(0.98, 1.00)	0.99	(0.98, 1.01)	0.4948
PUFA (%kcal)	6.90	(6.84, 6.96)	6.90	(6.83, 6.98)	6.89	(6.80, 6.98)	0.8155
n-3 (EPA+DHA) (g)	75.9	(73.5, 78.3)	72.5	(69.1, 75.9)	80.4	(77.2, 83.6)	0.0026
Total fiber (g/d)	13.4	(13.1, 13.7)	13.4	(13.0, 13.8)	13.5	(13.2, 13.8)	0.8203
Total sugar (%kcal)	24.6	(24.4, 24.8)	24.7	(24.5, 25.0)	24.4	(24.1, 24.7)	0.0901
Added sugar (%kcal)	16.3	(16.0, 16.5)	16.3	(15.9, 16.7)	16.2	(15.8, 16.5)	0.5606
Cholesterol (mg/day)	228.0	(224.6, 231.4)	223.4	(219.4, 227.5)	234.2	(229.0, 239.5)	0.0016
Sodium (mg/day)	2887.3	(2857.0, 2917.7)	2838.1	(2800.3, 2875.9)	2954.0	(2913.4, 2994.6)	<.0001
Calcium (mg/day)	925.3	(909.8, 940.9)	917.5	(895.3, 939.7)	935.8	(916.9, 954.8)	0.2225
Phosphorus (mg/day)	1116.2	(1102.5, 1130.0)	1101.5	(1082.1, 1120.8)	1136.2	(1119.6, 1152.9)	0.0076
Iron (mg/day)	14.2	(14.0, 14.3)	14.1	(13.9, 14.3)	14.2	(14.0, 14.5)	0.3944
Zinc (mg/day)	10.0	(9.87, 10.1)	9.88	(9.7, 10.0)	10.1	(9.95, 10.3)	0.0366
Potassium (mg/day)	1984.3	(1955.3, 2013.2)	1984.6	(1940.6, 2028.5)	1983.9	(1951.7, 2016.0)	0.9810
Vitamin A (RAE) (mcg)	570.6	(556.9, 584.2)	569.2	(549.3, 589.1)	572.4	(553.0, 591.9)	0.8300
Vitamin D (mcg/day)	6.07	(5.95, 6.20)	6.03	(5.8, 6.2)	6.13	(5.99, 6.28)	0.4126
Vitamin C (mg/day)	85.5	(82.2, 88.7)	86.3	(82.1, 90.5)	84.3	(80.9, 87.8)	0.4007

Abbreviations: EBW, Excess body weight (includes overweight and obesity); 95%C.L., 95% Confidence Limits; FA, Fatty Acids; PUFA, Polyunsaturated fatty acids. ^aAll the analyses take into account the sampling design of each survey. ^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obese. ^cUsual intake of each dietary variable was estimated using the NCI method (adjusted by gender, age, center, weekend, self-report intake amount - more, same or less than usual amount - and sequence - first or second 24HR). ^d p-values comparing least squares means (LS-means) of fixed effects for the usual intake of each nutrient, adjusted by energy (except for energy and energy density), sex, and age.

Comparing the diet quality indexes components of both populations, using the BHEI-R, adolescents from SOL-Youth presented higher (healthier) scores for total and whole fruits, milk and dairy, and whole grains than ISA-Nutrition, and adolescents from ISA-Nutrition presented higher scores for total vegetables, dark-green and orange vegetables and legumes (DGOV&L), saturated fat, sodium, and total calories from solid fat and added sugar (SoFAS) than SOL-Youth (Figure 1). The scores for total grains, meats, and oils were close to the maximum and very similar for both populations. Using the AHEI, adolescents from SOL-Youth presented higher scores than ISA-Nutrition for vegetables, whole fruits, whole grains, trans and omega-3 fats, while adolescents from ISA-Nutrition presented higher scores for nuts and legumes, red and processed meats, and polyunsaturated fatty acids (PUFA) than SOL-Youth. Both populations presented very low (unhealthier) scores for the component sugar sweetened beverages (SSB) and fruit juice and similar scores for sodium.

The total scores of both diet quality indices were higher for ISA-Nutrition than for SOL-Youth: 68.8 (68.1, 69.4) in ISA-Nutrition vs. 62.5 (61.8, 62.3) in SOL-Youth for BHEI-R, and 37.5 (36.8, 38.2) in ISA-Nutrition vs. 34.0 (33.6, 34.5) in SOL-Youth for AHEI-2010. Similar differences were noted when stratifying by EBW status: for BHEI-R: 69.1 (68.4, 69.9) in ISA-Nutrition vs. 62.5 (61.8, 63.2) in SOL-Youth for those without EBW, and 67.9 (66.8, 69.0) in ISA-Nutrition vs. 63.0 (62.1, 63.9) in SOL-Youth for those with EBW ($p=0.073$); for AHEI-2010: 37.5 (36.8, 38.3) in ISA-Nutrition vs. 34.1 (33.6, 34.7) in SOL-Youth for those without EBW, and 37.5 (36.4, 38.6) in ISA-Nutrition vs. 33.9 (33.4, 34.4) in SOL-Youth for

those with EBW. ISA-Nutrition participants with EBW (vs. without) had marginally lower (unhealthier) scores for whole grains using BHEI-R ($p=0.064$) and sugary beverages using AHEI-2010 ($p=0.065$). SOL-Youth participants with EBW had lower scores of nuts and legumes using AHEI, and sodium using BHEI-R, but higher scores of whole grains and dairy using BHEI-R (Figure 1; Supplemental Table 1).

In ISA-Nutrition, BHEI-R was inversely associated with EBW (OR: 0.87; 95% CI: 0.80, 0.95; $p=0.003$) and CVDR (OR: 0.89; 95% CI: 0.80, 0.98; $p=0.022$) and AHEI was marginally associated with CA (OR: 0.90; 95% CI: 0.79, 1.02; $p=0.098$) (Figure 2; Supplemental Table 2). In SOL-Youth, AHEI was inversely associated with EBW (0.93; 95% CI: 0.87, 0.99; $p=0.041$). No other significant associations for the cardiometabolic outcomes were noted for either diet quality index in the studied populations.

Figure 1: Comparison of means of components and BHEI-R and AHEI scores of adolescents from ISA-Nutrition and HCHS/SOL-Youth, according to nutritional status. Abbreviations: EBW, Excess body weight; SSB = Sugar sweetened beverages; DGOV&L = Dark-green and orange vegetables and legumes; Meats = Meats, eggs and legumes; Oils = Vegetable Oils, Seed Oils and Oily Fish; SoFAS = total calories from solid fat and added sugar. The maximum score for each component is described after each one, between brackets. *Differences between with and without EBW, compared using regression analysis for the mean scores of each component.

Figure 2: Odds ratio (95% CI) of Brazilian (BHEI-R) and Alternate (AHEI) Healthy Eating Indices according to the presence of EBW, CA, and CVDR in adolescents from the ISA-Nutrition and the HCHS/SOL-Youth.

The logistic regression models for ISA-Nutrition were adjusted for age, gender, and income. For HCHS/SOL-Youth, they were adjusted for gender, age, income, and Hispanic background. For both populations, they were also adjusted for total energy intake in the AHEI models, but not for BHEI-R, since it is estimated for 1000 kcal.

5.3.5 Discussion

Diet quality assessed using the BHEI-R was inversely associated with EBW and CVDR in Brazilian adolescents living in São Paulo and diet quality assessed using the AHEI was inversely associated with EBW among Hispanic/Latino adolescents living in USA. With small improvements in diet quality according to diet quality indices applicable to each population, Brazilian adolescents could lower the odds of EBW by 13% and the odds of CVDR by 11% with each additional unit increase in BHEI-R, while Hispanic/Latino adolescents in the US could lower the odds of EBW by 7% with each additional unit increase in AHEI.

Despite differences in nutrient intake observed across both surveys, few variations were observed between those with and without EBW in each population. This observation suggests that single nutrients may not be enough to detect differences between health-related outcomes, and, in this context, an overall diet quality index better distinguish these associations (SCHAP, 2017; MATTEI et al., 2016; MARSHALL et al., 2014). Still, the components of the diet quality indices themselves presented few differences between adolescents with and without EBW, and only for ISA-Nutrition population, the total BHEI-R was marginally higher for those without versus with EBW. However, after adjusting for confounding variables, BHEI-R was inversely associated with EBW in ISA-Nutrition and AHEI was inversely associated with EBW in SOL-Youth. This evidence reinforces the importance of using indices relevant to each specific population. Frequently, indices developed for a population (e.g., HEI or AHEI in USA) have been applied to other populations without adapting it to the scoring algorithm (SHAHRIL et al., 2013; DREWNOWSKI et al., 2009), but despite being considered culturally neutral due to

the use of food groups and nutrients (SCHAP, 2017), slight differences in dietary habits may be important and may reduce the strength of the association between diet quality and disease outcomes. Preferably, previous indices could be used as templates for a local diet quality index, adapted to each country scenario, and validated for each population (FISBERG et al., 2004; MCCULLOUGH e WILLETT, 2006; GUENTHER et al., 2013).

Other studies have shown health benefits by consuming an overall high diet quality (measured using various definitions) (SCHWINGSHACKL, 2018; SOTOS-PRIETO et al., 2017; LEISE et al., 2015). In youth, despite the importance of a high diet quality, the evidence linking *a priori* dietary patterns with health outcomes is sparse. In a systematic review investigating these associations in pediatric populations, weight status was the most commonly measured health-related outcome, with most of studies being conducted in developed countries (MARSHALL et al., 2014). However, the evidence was inconsistent, with studies finding both negative and positive associations, which may be the result of differences in study design (e.g., adjustment for confounding factors) or wide variation in scoring methodology. Nevertheless, results from prior investigations support that a high-quality diet in adolescence and young and middle adulthood is important for the maintenance of cardiovascular health and prevention of CVD later in life (DAHME et al., 2016; STEFFEN et al., 2014; LIU et al., 2012).

Findings from 16,220 children aged 2-9 years from study centers in 8 European countries, suggest that a Mediterranean diet score was inversely associated with EBW, but not clearly associated with fat distribution itself (TOGNON et al., 2014). In the study, the cross-sectional association between waist circumference and the

score was nonsignificant when the analyses were adjusted for parental income and education. Likewise, in the present study, CA was not associated with either AHEI or BHEI-R for either population. This observation could suggest the influence of factors other than diet quality in how body fat deposits in this age group, such as sex hormones (BJORNTORP et al., 1990), ethnic background (HUANG et al., 2001), gut microbiota (BOULANGÉ et al., 2016), and *in utero* and early childhood environment (FRANÇA et al., 2016).

In the present study, CVDR was inversely associated with diet quality in ISA-Nutrition, but not in SOL-Youth population. In parallel, while a study on a nationally-representative sample of US adolescents observed lower prevalence of metabolic syndrome with higher overall diet quality, measured using the Healthy Eating Index 2005 (PAN e PATT, 2008), another study showed an inverse association between Dietary Approaches to Stop Hypertension (DASH) score with systolic blood pressure among 11 to 13y and 14 to 18-year-olds, but did not detect significant associations between DASH-style diet and weight status, waist circumference, or diastolic blood pressure. On the other hand, another study in youth aged 6-18 years from Tehran found an inverse relationship between adherence to DASH score and metabolic syndrome and incidence of hypertension, high fasting plasma glucose, and abdominal obesity (ASGHARI et al., 2016). This evidence illustrates diversity in the association between diet quality and metabolic outcomes in youth across populations. Despite the observed variations, in both ISA-Nutrition and SOL-Youth those with EBW presented more CVDR than those without EBW, in accordance with the broad evidence showing this association (WILSON et al., 2002; HRUBY et al., 2016; KOLIAKI et al., 2018).

Studies suggest that diet quality seems to be important even in adolescents who are already obese. In a nationally-representative US sample, metabolically-healthy-obese adolescents had better dietary compliance to the U.S. guidelines when compared with metabolically-abnormal-obese, with higher total HEI-2005 score, higher milk scores, and higher scores from calories from solid fats, alcohol beverages, and added sugars (CAMHI et al., 2015). Also, in a Turkish study with 164 overweight or obese children (aged 9–13 years), there was a negative correlation between diet quality and body mass, waist circumference, and body fat mass (OZTURK et al., 2018).

Evaluating the components of the diet quality indexes allowed us to compare the diet of ISA-Nutrition and SOL-Youth populations. For example, the score of SOL-Youth on whole grains was higher than in ISA-Nutrition. This difference may have occurred from higher acculturation of this population to USA diet (ARANDIA et al., 2018), that have a higher intake of whole grains among adolescents, from ready-to-eat cereals, yeast breads/rolls, and crackers and salty grain snacks (McGILL et al., 2015). These foods are not very popular in the Brazilian adolescent diet (PEREIRA et al., 2017). On the other hand, beans are frequently consumed and represent the food group with the highest total fiber contribution in Brazil (LEVY et al., 2009; dos SANTOS et al., 2016), which is reflected in the higher score for nuts and legumes in ISA-Nutrition population compared to SOL-Youth. Another example of difference across both populations is the higher score of milk and dairy for SOL-Youth adolescents. It has been reported that the average intake of milk in Brazil is 54.5g (POSSA et al., 2017), whereas it is 266mL/day in the Central Latin America region (SINGH et al., 2015). The high intake of milk and dairy could have been a

traditional dietary habit maintained by the Hispanic/Latino population residing in the US.

Despite the contrasts, there are also similarities that should be highlighted, such as the very low score of both populations for SSB and fruit juices, indicating a high intake of these beverages, as observed in previous studies with adolescents (WANG et al., 2008; SINGH et al., 2015). SSB and fruit juice have a high sugar and energy content and have been consistently related to obesity and weight gain (LUGER et al., 2017) and other diseases (MICHA et al., 2017). SSB and fruit juices represent a key component for interventions intending to improve diet quality in adolescents of diverse populations.

Even with the observed differences and similarities of components, significant discrepancies exist between the overall diet quality and the recommendations for both studied populations. In spite of adolescence been a critical period regarding nutritional status, this life stage is marked by poor diet quality in several populations. In US, for example, >80% of adolescents were classified as having a poor diet (SHAY et al., 2013). In diverse studies, adolescents presented the poorest diet quality in comparison with both older (MELLO et al., 2018; HIZA et al., 2013) and younger (BANFIELD et al., 2016, GOLLEY et al., 2011) age groups. Nonetheless, Brazilian adolescents presented better diet quality than Hispanics/Latinos living in the USA using both scores. Even though Brazilian adolescents had less EBW than Hispanic/Latino adolescents from the US, they had higher prevalence of high systolic blood pressure and dyslipidemia. These differences may be result of several factors such as differences in lifestyle aspects that were not evaluated in this study, such as physical activity, sedentary behavior, access to health services, psychosocial factors,

in-utero environment, media and marketing exposure, and the physical environment (WHO, 2016; GREYDANUS et al., 2018), besides individual genetic variations (WOOD, 2015) or variations between ethnic backgrounds (SHTIR et al., 2009; CHOUDHRY et al., 2006) that may product different interplays between genes and dietary patterns, resulting different phenotypes.

A limitation of this study is that we did not account for individual ethnic differences that may occur in diet intake and diet-disease associations in the SOL-Youth study (MATTEI et al., 2016) due to sample size limitation. The results may reflect those from the predominant Mexican heritage group (48%), despite adjusting the models for ethnic background. In addition, the diet quality scores applied in the analysis were not developed specifically for adolescents. However, the basic food groups used in both scores are considered culturally neutral, which accounts for individual preferences within food groups, and are considered appropriate for this age group (SCHAP, 2017). Moreover, moderate alcohol intake, consistently associated with lower risk of CVD in adults (DAHME et al., 2016), was not included in the AHEI score for this population. Future studies investigating diet quality in adolescents could utilize tools developed specifically for this age group, especially if they are supported by validation studies.

There are several strengths of this study. It compares data of adolescents from two large surveys in different settings with high prevalence of EBW. ISA-Nutrition has a sampling design that represents all the adolescent population living in households in the urban area of São Paulo, the biggest city in Brazil and one of the most populous cities in the world, with more than 12 million habitants (IBGE, 2018). SOL-Youth is one of the largest and most comprehensive studies on cardiometabolic

health in a diverse sample of Hispanic/Latino youth living in four areas of the United States. Furthermore, both surveys followed an important methodological rigor, with similar quality of data. Both used two 24HR as dietary assessment, providing rich details about foods consumed, as well as culturally neutral data, which allowed the comparison of two culturally different diets. In addition, our analyses assessed both specific nutrients and overall diet quality, using indices applicable to each population (SCHAP, 2017; MARSHALL et al., 2014).

In conclusion, healthier diet quality was associated with lower odds of EBW in Brazilian and USA-Hispanic/Latino adolescents and with lower CVDR in Brazilian adolescents. Findings from this study suggest that measuring diet quality with indices relevant to each population may better represent the association of their diet quality with obesity and cardiometabolic outcomes in adolescents. Furthermore, we highlight common food groups that should be improved in both groups, such as sugar sweetened beverages, but also culturally-specific differences that could be targeted to each particular population in order to improve overall diet quality.

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Competing Interests

The authors declare that they have no conflict of interest.

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Table S1: Comparison of means of components and BHEI-R and A-HEI final scores of adolescents in the 2015 ISA-Nutrition and in the HCHS/SOL-Youth, according to nutritional status^a.

Components of the Healthy Eating Indexes (maximum score)	2015 ISA-Nutrition						
	Total adolescents (n=189)		Without EBW (n=135) ^b		With EBW (n=54) ^b		p ^c
	Mean	95% CL	Mean	95% CL	Mean	95% CL	
<i>Brazilian Healthy Eating Index (BHEI-R)</i>							
Total fruit, servings/1000 kcal (5)	2.65	(2.42, 2.88)	2.71	(2.43, 2.99)	2.51	(2.1, 2.93)	0.404
Whole fruit, servings/1000 kcal (5)	2.99	(2.74, 3.23)	2.96	(2.67, 3.26)	3.04	(2.6, 3.49)	0.748
Total vegetable, servings/1000 kcal (5)	4.84	(4.76, 4.92)	4.84	(4.75, 4.92)	4.84	(4.71, 4.97)	0.955
DGOV&L, servings/1000 kcal (5)	4.64	(4.47, 4.81)	4.68	(4.5, 4.85)	4.55	(4.25, 4.86)	0.378
Total grains, servings/1000 kcal (5)	5.00	(5.0, 5.0)	5.00	(5.0, 5.0)	5.00	(5.0, 5.0)	-
Whole grains, servings/1000 kcal (5)	0.29	(0.26, 0.32)	0.31	(0.27, 0.35)	0.25	(0.2, 0.3)	0.064
Milk and dairy, servings/1000 kcal (10)	4.58	(4.46, 4.69)	4.60	(4.47, 4.72)	4.52	(4.25, 4.8)	0.619
Meats, eggs and Legumes, servings/1000 kcal (10)	9.95	(9.92, 9.98)	99.59	(99.38, 99.8)	99.22	(98.5, 99.9)	0.298
Oils, servings/1000 kcal (10)	10.0	(10.0, 10.0)	10.0	(10.0, 10.0)	10.0	(10.0, 10.0)	-
Saturated fat, % energy (10)	7.81	(7.71, 7.92)	7.85	(7.74, 7.96)	7.73	(7.46, 7.99)	0.387
Sodium, g/1000 kcal (10)	8.83	(8.65, 9.01)	8.91	(8.7, 9.11)	8.63	(8.29, 8.96)	0.196
SoFAS, % energy (20)	7.20	(6.99, 7.41)	7.31	(7.07, 7.55)	6.93	(6.53, 7.33)	0.146
BHEI-R total (100)	68.8	(68.1, 69.4)	69.1	(68.4, 69.9)	67.9	(66.8, 69.0)	0.073

Abbreviations: EBW, Excess body weight (includes overweight and obesity); SSB = Sugar sweetened beverages; DGOV&L = Dark-green and orange vegetables and legumes; Oils = Vegetable Oils, Seed Oils and Oily Fish; SoFAS = total calories from solid fat and added sugar.

^aAll the analyses take into account the sampling design of each survey.

^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obese.

^cVariables are compared using regression analysis for the mean scores.

Table S1 (Cont): Comparison of means of components and BHEI-R and A-HEI final scores of adolescents in the 2015 ISA-Nutrition and in the HCHS/SOL-Youth, according to nutritional status^a.

Components of the Healthy Eating Indexes (maximum score)	HCHS/SOL-Youth						
	Total adolescents (n=787)		Without EBW (n=426) ^b		With EBW (n=361) ^b		p ^c
	Mean	95% CL	Mean	95% CL	Mean	95% CL	
<i>Brazilian Healthy Eating Index (BHEI-R)</i>							
Total fruit, servings/1000 kcal (5)	3.67	(3.6, 3.8)	3.65	(3.5, 3.8)	3.71	(3.6, 3.9)	0.598
Whole fruit, servings/1000 kcal (5)	3.82	(3.7, 4)	3.77	(3.6, 3.9)	3.89	(3.7, 4.1)	0.335
Total vegetable, servings/1000 kcal (5)	3.15	(3.1, 3.2)	3.09	(3, 3.2)	3.23	(3.1, 3.4)	0.143
DGOV&L, servings/1000 kcal (5)	1.08	(1, 1.1)	1.07	(1, 1.2)	1.08	(1, 1.2)	0.908
Total grains, servings/1000 kcal (5)	5.00	(5, 5)	5.00	(5, 5)	5.00	(5, 5)	-
Whole grains, servings/1000 kcal (5)	3.58	(3.4, 3.7)	3.47	(3.3, 3.6)	3.72	(3.6, 3.9)	0.028
Milk and dairy, servings/1000 kcal (10)	7.49	(7.3, 7.7)	7.37	(7.1, 7.6)	7.64	(7.4, 7.9)	0.062
Meats, eggs and Legumes, servings/1000 kcal (10)	10.00	(10, 10)	10.00	(10, 10)	10.00	(10, 10)	-
Oils, servings/1000 kcal (10)	10.00	(10, 10)	10.00	(10, 10)	10.00	(10, 10)	-
Saturated fat, % energy (10)	6.51	(6.4, 6.6)	6.47	(6.3, 6.6)	6.56	(6.4, 6.8)	0.442
Sodium, g/1000 kcal (10)	2.61	(2.5, 2.7)	2.82	(2.7, 3)	2.33	(2.2, 2.5)	<.0001
SoFAS, % energy (20)	5.61	(5.4, 5.8)	5.45	(5.1, 5.8)	5.83	(5.5, 6.2)	0.147
BHEI-R total (100)	62.5	(61.8, 63.2)	62.2	(61.2, 63.1)	63.0	(62.1, 63.9)	0.240

Abbreviations: EBW, Excess body weight (includes overweight and obesity); SSB = Sugar sweetened beverages; DGOV&L = Dark-green and orange vegetables and legumes; Oils = Vegetable Oils, Seed Oils and Oily Fish; SoFAS = total calories from solid fat and added sugar.

^aAll the analyses take into account the sampling design of each survey.

^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obese.

^cVariables are compared using regression analysis for the mean scores.

Table S1 (Cont): Comparison of means of components and BHEI-R and A-HEI final scores of adolescents in the 2015 ISA-Nutrition and in the HCHS/SOL-Youth, according to nutritional status^a.

Components of the Healthy Eating Indexes (maximum score)	2015 ISA-Nutrition						
	Total adolescents (n=189)		Without EBW (n=135) ^b		With EBW (n=54) ^b		p ^c
	Mean	95% CL	Mean	95% CL	Mean	95% CL	
<i>Alternate Healthy Eating Index (AHEI2010)</i>							
Vegetables without potatoes, servings/day (10)	1.84	(1.73, 1.95)	1.90	(1.79, 2.01)	1.70	(1.54, 1.87)	0.074
Whole Fruit, servings/day (10)	1.61	(1.39, 1.83)	1.64	(1.39, 1.88)	1.53	(1.05, 2.01)	0.713
Whole grains, servings/day (10)	1.06	(0.97, 1.15)	1.09	(0.99, 1.19)	1.00	(0.90, 1.09)	0.236
Sugar sweetened beverages and fruit juice, servings/day (10)	0.25	(0.14, 0.35)	0.30	(0.16, 0.43)	0.13	(0.04, 0.22)	0.065
Nuts and legumes, servings/day (10)	7.62	(7.27, 7.97)	7.76	(7.38, 8.14)	7.27	(6.63, 7.91)	0.179
Red/processed meat, servings/day (10)	2.36	(2.11, 2.62)	2.34	(2.09, 2.58)	2.43	(2.08, 2.78)	0.696
Trans Fat, % energy (10)	7.75	(7.69, 7.81)	7.76	(7.69, 7.83)	7.73	(7.61, 7.85)	0.688
Long-chain (n-3) fats (EPA+DHA), mg/day (10)	1.72	(1.63, 1.82)	1.72	(1.61, 1.83)	1.74	(1.48, 2.00)	0.897
Polyunsaturated fatty acids (PUFA), % energy (10)	8.06	(7.97, 8.15)	8.03	(7.93, 8.14)	8.12	(7.94, 8.29)	0.412
Sodium, mg/day (10)	5.23	(4.75, 5.71)	5.00	(4.43, 5.56)	5.81	(4.98, 6.63)	0.115
AHEI total (100)	37.5	(36.8, 38.2)	37.5	(36.8, 38.3)	37.5	(36.4, 38.6)	0.938

Abbreviations: EBW, Excess body weight (includes overweight and obesity); SSB = Sugar sweetened beverages; DGOV&L = Dark-green and orange vegetables and legumes; Oils = Vegetable Oils, Seed Oils and Oily Fish; SoFAS = total calories from solid fat and added sugar.

^aAll the analyses take into account the sampling design of each survey.

^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obese.

^cVariables are compared using regression analysis for the mean scores.

Table S1 (Cont): Comparison of means of components and BHEI-R and A-HEI final scores of adolescents in the 2015 ISA-Nutrition and in the HCHS/SOL-Youth, according to nutritional status^a.

Components of the Healthy Eating Indexes (maximum score)	HCHS/SOL-Youth						
	Total adolescents (n=787)		Without EBW (n=426) ^b		With EBW (n=361) ^b		p ^c
	Mean	95% CL	Mean	95% CL	Mean	95% CL	
<i>Alternate Healthy Eating Index (AHEI2010)</i>							
Vegetables without potatoes, servings/day (10)	2.20	(2.13, 2.28)	2.22	(2.12, 2.32)	2.18	(2.10, 2.25)	0.506
Whole Fruit, servings/day (10)	2.00	(1.91, 2.09)	2.02	(1.90, 2.14)	1.97	(1.87, 2.06)	0.490
Whole grains, servings/day (10)	2.37	(2.27, 2.46)	2.35	(2.22, 2.47)	2.39	(2.27, 2.5)	0.671
Sugar sweetened beverages and fruit juice, servings/day (10)	0.02	(0.01, 0.04)	0.02	(0, 0.04)	0.03	(0.01, 0.05)	0.498
Nuts and legumes, servings/day (10)	4.08	(3.87, 4.29)	4.30	(4, 4.59)	3.79	(3.57, 4)	0.011
Red/processed meat, servings/day (10)	0.00	(0, 0.002)	0.00	(0, 0.0005)	0.00	(0, 0.005)	0.027
Trans Fat, % energy (10)	8.61	(8.57, 8.64)	8.61	(8.57, 8.64)	8.60	(8.54, 8.66)	0.879
Long-chain (n-3) fats (EPA+DHA), mg/day (10)	3.15	(3.03, 3.27)	3.09	(2.93, 3.26)	3.22	(3.05, 3.40)	0.321
Polyunsaturated fatty acids (PUFA), % energy (10)	6.17	(6.09, 6.26)	6.22	(6.12, 6.33)	6.11	(5.99, 6.22)	0.151
Sodium, mg/day (10)	5.45	(5.15, 5.75)	5.31	(4.94, 5.67)	5.63	(5.19, 6.07)	0.277
AHEI total (100)	34.0	(33.6, 34.5)	34.1	(33.6, 34.7)	33.9	(33.4, 34.4)	0.585

Abbreviations: EBW, Excess body weight (includes overweight and obesity); SSB = Sugar sweetened beverages; DGOV&L = Dark-green and orange vegetables and legumes; Oils = Vegetable Oils, Seed Oils and Oily Fish; SoFAS = total calories from solid fat and added sugar.

^aAll the analyses take into account the sampling design of each survey.

^bBody weight status was defined according to IOTF cutoff points; With excess body weight: overweight and obese.

^cVariables are compared using regression analysis for the mean scores.

Table S2: Odds ratio (95% CI) of Brazilian and Alternate Healthy Eating Indexes according to the presence of excess body weight, central adiposity, and cardiovascular risk factors count in adolescents in the 2015 ISA-Nutrition and in the HCHS/SOL-Youth.

	2015 ISA-Nutrition					
	BHEI-R			AHEI-2010		
	OR	95%CI	p	OR	95%CI	p
Excess Body Weight	0.874	(0.80, 0.95)	0.003	0.945	(0.86, 1.04)	0.226
Central Adiposity (waist circ.$\geq$90%ile)	1.007	(0.89, 1.15)	0.912	0.900	(0.79, 1.02)	0.098
CVD Risk Factors Count (3 or more)	0.887	(0.80, 0.98)	0.022	0.954	(0.87, 1.04)	0.284
	HCHS/SOL-Youth					
	BHEI-R			AHEI-2010		
	OR	95%CI	p	OR	95%CI	p
Excess Body Weight	1.026	(0.98, 1.07)	0.246	0.929	(0.87, 0.99)	0.041
Central Adiposity (waist circ.$\geq$90%ile)	1.063	(0.996, 1.14)	0.067	0.977	(0.90, 1.06)	0.598
CVD Risk Factors Count (3 or more)	1.048	(0.99, 1.11)	0.109	0.994	(0.92, 1.07)	0.876

Abbreviations: EBW, Excess body weight (includes overweight and obesity); CA, Central Adiposity (waist circ. $\geq$ 90%ile); CVDR, Cardiovascular Disease Risk Factors Count (3 or more); OR, Odds Ratio; 95%CI, 95% Confidence interval.

^aAll the analyses take into account the sampling design of each survey. The logistic regression models for 2015 ISA-Nutrition were adjusted for age, gender, and income. For HCHS/SOL-Youth, they were adjusted for gender, age, income, and Hispanic background. For both populations, they were also adjusted for energy in the AHEI models. For BHEI, the energy adjustment is not necessary, since it is estimated for 1000kcal.

6. CONSIDERAÇÕES FINAIS

O presente estudo contribuiu para a melhor compreensão da distribuição do excesso de peso na cidade de São Paulo e de como sua prevalência mudou no período de 12 anos. Nossos achados indicam que o excesso de peso aumentou substancialmente em curto espaço de tempo e de forma mais relevante em grupos específicos da população, como adolescentes e adultos do sexo feminino. Os fatores associados ao excesso de peso, como sexo, renda, faixa etária e tabagismo, podem fornecer informações importantes para a revisão de intervenções existentes ou criação de novas medidas a fim de diminuir a tendência de crescimento para os próximos anos.

Além disso, foi possível observar modificações na dieta da população neste período, sendo verificada diversidade nas mudanças no tamanho das porções e na contribuição energética dos grupos de alimentos consumidos, com aumento de alguns grupos e redução de outros. Para a população total, o tamanho das porções de carne branca, salgados, ovos e café e chá aumentou no período analisado e as porções de arroz, carne vermelha, doces, massas, sanduíches e frios diminuiu. Ainda, foi possível observar a associação do maior tamanho da porção de 11 grupos de alimentos com o excesso de peso (frios, salgados fritos, sucos de frutas e industrializados, pizza, carne vermelha, arroz, salgados, refrigerantes, sopas e açúcar).

Por fim, verificamos que a maior qualidade da dieta foi associada à menor chance de ter excesso de peso em adolescentes de São Paulo e em latinos vivendo nos EUA, além de menor risco cardiovascular entre os brasileiros. Esses achados indicam que medir a qualidade da dieta com índices desenvolvidos para cada população específica pode identificar melhor sua associação com obesidade e fatores de risco cardiometabólico em adolescentes. Também destacamos a necessidade de melhora na qualidade do consumo de alguns grupos de alimentos, como bebidas açucaradas, em ambas as populações. Porém diferenças específicas que podem ser direcionadas para cada população em particular foram identificadas, como o baixo consumo de grãos integrais entre os paulistanos e o elevado consumo de carnes vermelhas e processadas entre os latinos nos EUA, a fim de melhorar a qualidade geral da dieta em ambas populações.

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ANEXOS

ANEXO 1 – Relação dos grupos de alimentos formados a partir do consumo da população paulistana para avaliação do tamanho da porção.

Grupo	Alimentos pertencentes ao grupo
Arroz	Arroz branco, preto e integral
Massas	Macarrão, nhoque, massas recheadas
Pães	Pães brancos e integrais
Torradas e biscoitos	Torradas e biscoitos doces e salgados, simples e recheados
Frutas	Frutas frescas, exceto limão (tempero)
Verduras	Folhas (alface, repolho, escarola, acelga...)
Vegetais enlatados	Cogumelo, <i>pickles</i> , azeitona, nabo, ervilha, cenoura, milho, entre outros enlatados
Legumes	Tomate, cenoura, beterraba, pepino, brócolis, entre outros
Carne vermelha	Carnes bovinas e suínas (frescas e processadas)
Carne branca	Carnes de peixes, aves e frutos do mar (frescas e processadas)
Achocolatado	Achocolatados e bebidas lácteas de outros sabores prontos para beber
Achocolatado em pó	Achocolatados e bebidas lácteas de outros sabores EM PÓ
Queijos	Queijos amarelos e brancos
Leite	Leite integral, semi-desnatado e desnatado
Lácteos	Iogurtes, vitaminas com frutas, entre outros
Ovos	Ovos fritos, cozidos, entre outros modos de preparo
Leguminosas (exceto feijões)	Lentilha, ervilha, grão de bico, soja, entre outros
Feijões	Feijão carioca, preto, branco, vermelho
Manteiga e margarina	Manteiga e margarina, com e sem sal
Bolos	Bolos simples e recheados
Doces	Chocolates, sorvetes, doces caseiros, entre outros
Petiscos fritos	Batata, polenta, cebola fritas
Sanduíches	Lanche de rede fast-food, X-salada, cachorro quente, pão com frios, entre outros
Salgados	Coxinha, esfiha, pastel, empada, pão de batata, entre outros fritos e assados
Pizza	Pizzas salgadas e doces
Cafés e chás	Cafés e chás com e sem cafeína
Refrigerante	Refrigerantes tradicionais e diet
Suco natural	Sucos de fruta naturais
Suco industrializado	Sucos de frutas industrializados
Bebidas alcoólicas	Bebidas alcoólicas fermentadas e destiladas
Frios	Mortadela, presunto, salame, rosbife, peito de peru, entre outros
Açúcar	Açúcar de adição
Molhos	Molhos, cremes, maionese, catchup, mostarda, entre outros
Condimentos	Cebola, alho, pimenta, orégano, entre outros

Óleos	Óleo de soja, de milho, azeite, entre outros
Sal	Sal adicionado
Vinagre	Vinagre tinto, de maçã, balsâmico, entre outros
Cereais	Mingaus, cereais matinais, aveia
Tubérculos e raízes	Tubérculos e raízes não fritos (batata, mandioca, inhame)
Sopas	Sopas e cremes, inclusive com legumes, macarrão
Salgadinhos	Salgadinho de milho, de trigo, batata frita <i>chips</i> , entre outros
Pipoca	Pipoca salgada e doce
Patês	Patê de atum, de presunto, de ricota, entre outros
Tortas	Tortas e suflês
Oleaginosas	Amêndoas, castanha de caju, castanha do Pará, nozes, entre outros
Outros	Preparações diversas: sushi, guacamole, yakisoba, virado à paulista, feijoada, risoto...

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Última atualização do currículo em 21/09/2018

Graduada em Nutrição pela Universidade São Camilo (1984), mestre em Ciências Biológicas pela Universidade Federal de São Paulo (1989), doutora em Ciências Biológicas pela Universidade Federal de São Paulo (1994) e livre-docente em Saúde Pública pela Faculdade de Saúde Pública da USP (2005). Sua carreira de pesquisadora orientadora (já formou 18 mestres e 8 doutores) foi feita no Departamento de Nutrição da Faculdade de Saúde Pública da USP, com ênfase em Técnicas e Métodos na Avaliação Nutricional de População, atuando principalmente nos seguintes temas: epidemiologia nutricional, consumo alimentar, dieta e recomendações nutricionais. De vários projetos pesquisa, realizados com apoio das agências de fomento nacionais e internacionais e em colaboração com outros pesquisadores, resultaram 8 livros e mais de 150 publicações de artigos científicos (índice H=18 ISI). É bolsista de produtividade em pesquisa nível 1D, do CNPq, desde 2003 e líder do diretório de grupos de pesquisa. É membro do corpo editorial da Revista Brasileira de Epidemiologia e da Revista de Nutrição e tem atuado como revisor regular em revistas nacionais e internacionais. Integra o Grupo de Trabalho sobre Nutrição e Alimentos para Fins Especiais (GTNFSDU) do Codex Alimentarius, da ANVISA, entre 2011 e 2017. Participa ativamente em funções de gestão científica e acadêmica da Universidade, sendo representante da categoria professor Associado 3 no Departamento de Nutrição e na Congregação. Foi presidente da Comissão de Graduação da Faculdade de Saúde Pública entre 2005 e 2011 e Chefe de Departamento entre 2014 e 2016. (Texto informado pelo autor)

Identificação

Nome	Regina Mara Fisberg
Nome em citações bibliográficas	FISBERG, R. M.; Fisberg, Regina Mara; FISBERG, R; Fisberg, Regina M.; Fisberg, R M; Mara Fisberg, Regina; Global Burden of Diseases Nutrition and Chronic Disease Expert Group (NutriCoDE); FISBERG, REGINA; Global Burden of Diseases Nutrition and Chronic Disease Expert Group (NUTRICODE); NutriCoDE; Global Burd Dis Nutr; GLOBAL BURDEN OF DISEASES, INJURIES, AND RISK FACTORS METABOLIC RISK FACTORS OF CHRONIC DISEASES EXPERT GROUP AND NUTRITION AND CHRONIC DISEASES EXPERT GROUP (NUTRICODE)

Endereço

Endereço Profissional	Universidade de São Paulo, Faculdade de Saúde Pública. USP - Faculdade de Saúde Pública - Dpto. de Nutrição - Av. Dr. Arnaldo, 715 Cerqueira Cesar 01246-904 - São Paulo, SP - Brasil Telefone: (11) 30617869 Fax: (11) 30626748 URL da Homepage: http://www.fsp.usp.br
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Formação acadêmica/titulação

1991 - 1994	Doutorado em Ciências Biológicas (Biologia Molecular). Universidade Federal de São Paulo, UNIFESP, Brasil. Título: Influência da ingestão alimentar nos níveis de zinco, cobre e superóxido dismutase de crianças normais e pacientes com fenilcetonúria, Ano de obtenção: 1994. Orientador: Maria Eugênia da Silva Fernandes. Bolsista do(a): Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq, Brasil. Palavras-chave: fenilcetonúria; micronutrientes; zinco e cobre. Grande área: Ciências da Saúde
1987 - 1989	Mestrado em Ciências Biológicas (Biologia Molecular). Universidade Federal de São Paulo, UNIFESP, Brasil. Título: Avaliação antropométrica de crianças fenilcetonúricas submetidas a dieta de

Jaqueline Lopes Pereira França

Endereço para acessar este CV: <http://lattes.cnpq.br/5131177533218586>
Última atualização do currículo em 28/11/2016

Graduada em Nutrição pela Faculdade de Saúde Pública da Universidade de São Paulo (2012) e Mestre em Ciências pela mesma instituição (2014) na área de Nutrição em Saúde Pública. Tem experiência na área de Nutrição, com ênfase em avaliação do consumo alimentar, epidemiologia nutricional, análise de banco de dados, variabilidade da dieta e sobrepeso e obesidade. Atualmente é doutoranda do Programa Nutrição em Saúde Pública da Faculdade de Saúde Pública da USP. (Texto informado pelo autor)

Identificação

Nome	Jaqueline Lopes Pereira França
Nome em citações bibliográficas	PEREIRA, J. L.; Pereira, J. L.; Pereira, Jaqueline Lopes; Pereira, JL

Endereço

Endereço Profissional	Universidade de São Paulo, Faculdade de Saúde Pública. Av. Dr. Arnaldo, 715 Cerqueira César 01246904 - São Paulo, SP - Brasil - Caixa-postal: 01246904 Telefone: (11) 30617804 URL da Homepage: http://www.fsp.usp.br
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Formação acadêmica/titulação

2015	Doutorado em andamento em Nutrição em Saúde Pública. Faculdade de Saúde Pública, FSP, Brasil. Título: Dieta e excesso de peso em adolescentes da cidade de São Paulo - panorama da última década e interação com polimorfismos., Orientador: Regina Mara Fisberg. Bolsista do(a): Fundação de Amparo à Pesquisa do Estado de São Paulo, FAPESP, Brasil. Palavras-chave: obesidade; epidemiologia nutricional; consumo alimentar.
2012 - 2014	Mestrado em Nutrição em Saúde Pública. Faculdade de Saúde Pública, FSP, Brasil. Título: Porções de alimentos e número de refeições realizadas por adultos e idosos do município de São Paulo: relação com excesso de peso e perfil lipídico., Ano de Obtenção: 2014. Orientador: Regina Mara Fisberg. Bolsista do(a): Fundação de Amparo à Pesquisa do Estado de São Paulo, FAPESP, Brasil. Palavras-chave: tamanho de porção; número de refeições; consumo alimentar; obesidade; perfil lipídico. Grande área: Ciências da Saúde Grande Área: Ciências da Saúde / Área: Nutrição / Subárea: Bioquímica da Nutrição. Setores de atividade: Pesquisa e desenvolvimento científico.
2007 - 2011	Graduação em Nutrição. Universidade de São Paulo, USP, Brasil.

Formação Complementar

2015 - 2015	Análise Multinível em Estudos Epidemiológicos. (Carga horária: 20h). Faculdade de Saúde Pública, FSP, Brasil.
2009 - 2011	Extensão universitária em Bandeira Científica. (Carga horária: 900h). Universidade de São Paulo, USP, Brasil.
2009 - 2011	Extensão universitária em Empresa Junior de Nutrição, USP. (Carga horária: 900h). Faculdade de Saúde Pública, FSP, Brasil.
2010 - 2010	Abordagens Nutricionais no Tratamento da Obesidade. (Carga horária: 54h). Instituto de Pediatria do Hospital das Clínicas da FMUSP. IDO - HC FMUSP. Brasil.