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Weight gain and changes in nutritional status of Brazilian adults after 20 years of age: a time-trend analysis (2006-2012)

Ganho de peso e mudança do estado nutricional de brasileiros após os 20 anos de idade: uma análise de série temporal (2006–2012)

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ABSTRACT: ***Objective:*** To analyze weight gain (WG) and change in nutritional status (NS) after the age of 20 years in the Brazilian adult population between 2006 and 2012. ***Methods:*** Time series using seven surveys from the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL). The analyses were stratified by region, age, sex and education, considering the sampling weights and complex design. In addition, relative weight change (RWC) in the period was determined for each category of independent variables using linear regression models. ***Results:*** Analyses showed an increase in WG after 20 years in two vectors: by survey year and age group, where the increase was higher in women. From 2006 to 2012, individuals 25–29 years old (women: RWC = 70%; β_{year} = 0.54 kg/year) and 30–34 years old (women: RWC = 56%; β_{year} = 0.57 kg/year) showed greater RWC. In 2012, the higher WG occurred in the age groups of 21–24 and 25–29 years old. Regarding the change in NS, individuals who were overweight at 20 years had a higher probability of remaining in this condition (or shifting to obesity) over time. However, among those who had a normal weight, the probability of not becoming overweight or obese was > 80%, independently of sex. ***Conclusion:*** The Brazilian population displayed progressive WG in adulthood, especially in the first decade after the age of 20, in addition to the period effect. On the other hand, individuals with normal weight in their 20s tended to maintain the same condition.

Keywords: Obesity. Nutritional Status. Weight Gain. Health Surveys. Health Surveillance.

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RESUMO: ***Objetivos:*** Analisar o ganho de peso (GP) e a mudança do estado nutricional (EN) após os 20 anos de idade na população brasileira entre os anos de 2006 e 2012. ***Metodologia:*** Série temporal com base em sete inquéritos transversais do Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico (VIGITEL). As análises foram estratificadas por região, faixa etária, sexo e escolaridade, considerando-se o plano e a ponderação amostral. Ainda, estimou-se a variação ponderal relativa (VPR) no período para os estratos analisados por meio de modelos de regressão linear. ***Resultados:*** Identificaram-se dois vetores de aumento no GP após os 20 anos de idade: ano do inquérito e faixa etária, que foram mais expressivos entre as mulheres. Entre 2006 e 2012, as faixas etárias que apresentaram a maior variação temporal foram de 25–29 (mulheres: VPR = 70%; β_{ano} = 0,54 kg/ano) e 30–34 anos (mulheres: VPR = 56%; β_{ano} = 0,57 kg/ano). Em 2012, o maior aumento de GP ocorreu nas faixas etárias de 21–24 e 25–29 anos. Quanto à mudança de EN, indivíduos que apresentavam excesso de peso aos 20 anos tiveram maior probabilidade de permanecer nessa condição (ou migrar do sobrepeso para obesidade) com o avançar da idade. Contudo, entre os que eram eutróficos, a probabilidade de permanecer com o mesmo EN foi > 80%, independentemente do sexo. ***Conclusão:*** Além do efeito tempo, a população brasileira apresentou progressivo GP no decorrer da fase adulta, sobretudo na primeira década após os 20 anos. Por outro lado, indivíduos eutróficos aos 20 anos tenderam a permanecer nessa condição.

Palavras-chave: Obesidade. Estado Nutricional. Ganho de Peso. Inquéritos Epidemiológicos. Vigilância em Saúde.

INTRODUCTION

According to an analysis of 1,698 national health surveys produced by Non Communicable Diseases Risk Factor Collaboration, it was found that, between 1975 and 2014, the prevalence of obesity among men and women increased, respectively, by 237.5 and 132.8% [1], making the most frequent nutritional deviation in the world[2].

In Brazil, the prevalence of overweight between 1974 and 2009 increased from 18.5% to 50.1% in men and from 28.7 to 48% in women[3]. Data from the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), from 2006 to 2016, also revealed an upward trend in obesity (BMI > 30 kg/m²) among men (from 11.3 to 18.1%) and women (from 11.5 to 19.6%)[4,5]. This epidemiological panorama included Brazil in the third (4.5%) and fifth (4.8%) place in terms of contribution to global obesity among men and women, respectively[1].

The adulthood represents a period of high behavioral, social and economic complexity, in which different degrees of autonomy and responsibility are manifested, directly impacting the lifestyles of individuals and communities[6].

Thus, it is essential to study obesity in adults according to the perspective of life cycles, since excessive weight accumulation generally refers to a chronic and dynamic process, with direct implications for the development of other chronic noncommunicable diseases (NCDs) [7,8].

However, there is little research in Brazil that offers information on the nutritional status of adults in different periods of life, especially with nationwide representativeness, limiting the production of relevant information for an in-depth look at the obesity epidemic and, consequently, to guide policies public policies for dealing with NCDs. Therefore, the objective of this study was to analyze the pattern of weight gain and the change in nutritional status of Brazilians after the age of 20, using data from seven VIGITEL surveys, separating the analyses by sex, region, age group and schooling and also analyzing the period effect between 2006 and 2012.

METHODS

STUDY DESIGN

VIGITEL is a cross-sectional telephone survey with complex probabilistic sampling carried out annually since 2006 in the capitals of the 26 Brazilian states and in the Federal District (DF), and it is aimed at monitoring the frequency and distribution of the main determinants of NCDs in the population over 18 years of age. The first stage of sampling consists of a systematic and stratified drawing, by telephone per city and postal code, totaling 5,000 numbers; only active residential numbers are considered, and the call must be answered within six attempts made at different times. In the second step, an adult living in the household drawn in the previous step is randomly selected. Details on the design of VIGITEL are described in official publications[5].

SELECTION CRITERIA

Although there are more recent editions of VIGITEL available, we used in our study the data up to 2012, since this was the last year in which the question that originated the outcome variable was asked ("Do you remember what your approximate weight was around 20 years of age?").

For the analysis, pregnant women (n = 2,976), individuals aged <21 years (n = 23,229) and the elderly (age >59 years; n = 72,012) were excluded, since the characteristics of the body compartments and their relationship with body mass index (BMI) differ from the average adult population.

Also, to avoid distortions in the estimates of weight change resulting from information bias and biologically improbable values, we excluded:

- individuals with a BMI < 16 kg/m^2, based on the body mass profile compatible with eating disorders[9] (n = 9,447);
- individuals with BMI ≥ 6 SDs (53.75 kg/m^2; n = 703) of the standardized distribution ($\mu = 0$; $\sigma = 1$ SD) calculated on the basis of the sample itself at the time of the survey

(alluding to the cutoff point used in the anthropometric assessment of children according to the *Z* score of the BMI-for-age[10]).

VARIABLES STUDIED

The outcome variables were weight gain after 20 years of age (calculated by the difference in weight (kg) at the time of the survey), the relative weight change (RWC, %) between the surveys and the change in nutritional status after 20 years.

RWC is the difference between the average weight gain in 2012 and 2006, divided by the average in 2006, multiplying by 100. This estimate was calculated for each category of the independent variables studied (age, region of residence and education).

The classification of nutritional status was based on BMI[11], calculated by dividing the self-reported weight (current and at 20 years old) by the current height squared (kg/m^2); individuals were classified as normal weight (BMI <25 kg/m^2, overweight (BMI ≥ 25 and <30 kg/m^2) or obese (BMI ≥30 kg/m^2).

The change in nutritional status was established with reference to the classification at age 20. The analyses were stratified into three periods (2006–2008, 2009–2010 and 2011–2012) and by age group (21–24 years, 25–29 years, 30–34 years, 35–44 years and 45–59 years), according to the categorization of the Family Budget Survey (POF) 2008/093.

The Brazilian macro-regions were divided into two groups: North (N), Northeast (NE) plus Central-West (CW) and Southeast (SE) plus South (S), which describes the regions with the lowest and highest level of socioeconomic development, respectively. The educational levels were based on the respondent's study time, being categorized as 0–8 years, 9–11 years and 12 years or more.

DATA ANALYSIS

The VIGITEL microdata are public domain and are available at: http://svs.aids.gov.br/bases_vigitel_viva/. The data collection and analysis procedures were performed on Stata 13.0 (Stata Corp., College Station, TX, USA). To incorporate weighting effects and complex design of the sample, the analyses were performed using the prefix *svy*.

All analyses were stratified by sex and the estimates of weight gain (kg) and change in nutritional status (%) were presented with respective standard errors (SE).

The period effect (2006–2012) in the analysis of weight gain after the age of 20 was estimated using simple linear regression specific to the region of residence, age group and education. The regression coefficients, with the respective p values, represent the mean temporal weight change per year of the survey (kg/year). Furthermore, the interaction between age group and survey year was graphically analyzed to determine the effect of these variables

on weight gain. Later, this analysis was repeated, stratifying it by the presence or absence of obesity at 20 years of age.

ETHICAL ASPECTS

Informed consent was obtained orally through telephone contact with the respondents. VIGITEL was approved by the National Research Ethics Commission and, because it uses anonymized data in the public domain, this analysis did not require a new ethical assessment.

This paper is the result of a master's thesis by Karine Maria de Melo Brebal, through the Postgraduate Program in Nutrition, Faculty of Nutrition, Federal University of Alagoas.

RESULTS

After excluding missing and biologically implausible data (30%), the sample in the seven surveys was composed of 191,553 Brazilian adults between 21 and 59 years old; 51.3% were female, 44.7% lived in the N, NE and CW regions and 70% had 8 years or less of study.

We found that in the study period (2006–2012), there was an increase in mean weight gain from the age of 20, with the temporal trend's effect size (regression coefficient and RWC) being greater among women, according to region, education and age group (Tables 1 and 2).

Regarding education, although the RWC of women with more education (46.9%) was 2.33 times higher than the RWC of those with up to 8 years of study (20.1%), an inverse exposure-response relationship was identified between mean weight gain after 20 years old and the study time, regardless of the year of the survey (Table 2).

The pattern of men gaining weight after the age of 20, according to age, did not change between 2006 and 2012, with the age group of 30-34 years being the one with the greatest change in mean weight gain (RWC = 19%; β_{year} = 0.31 kg/year; p = 0.003). When analyzing the age group vector in the last survey (2012), it was seen that the greatest increase in weight gain occurred in the age groups up to 21–24 years (4.3 kg) and 21–24 to 25–29 years (4.7 kg), reducing the absolute differences by more than 50% in the higher age groups (Table 1 and Figure 1A).

In women, a transition process was identified in the age group with the greatest weight gain, in which the youngest started to gain more weight than those in the more advanced age groups. In 2006, the intervals between the age groups of 30–34 and 35–44 years (3.7 kg) and 35–44 and 45–59 years (4.2 kg) showed the greatest increases in weight gain. On the other hand, in 2012, the greatest weight gain occurred in the intervals up to 21–24 years (3.4 kg) and between 21–24 and 25–29 years (5.1 kg) (Table 2 and Figure 1B). This change in

profile was due to the marked relative increase in mean weight gain in the 25–29 age group (RWC = 70%; β year = 0.54 kg/year; $p < 0.001$).

Figure 1 also demonstrates that there was a difference in weight gain according to nutritional status at age 20, in which normal weight individuals had a higher mean weight gain compared to those who were obese.

Table 1. Temporal change in weight gain (kg) in Brazilian men, according to region, age group and education. Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), 2006–2012 (n = 81,180).

Sociodemographic variables	2006	2007	2008	2009	2010	2011	2012	B_{YEAR} p	RWC (%)**
	Mean weight gain (kg)* [SE]								
Region									
N/NE/CW	10.1 [0.17]	10.4 [0.20]	10.6 [0.17]	10.6 [0.20]	11.3 [0.19]	11.6 [0.17]	11.6 [0.22]	0.27 < 0.001	14.8
S/SE	10.2 [0.31]	10.9 [0.34]	11.5 [0.37]	10.6 [0.28]	11.2 [0.37]	12.0 [0.34]	11.5 [0.37]	0.20 0.014	12.7
Age group (years)									
21–24	4.3 [0.30]	4.3 [0.35]	4.7 [0.34]	4.3 [0.34]	3.8 [0.29]	4.5 [0.41]	4.3 [0.42]	-0.02 0.749	0
25–29	8.4 [0.37]	8.2 [0.42]	8.6 [0.50]	8.5 [0.38]	8.5 [0.54]	10.3 [0.39]	9.0 [0.48]	0.22 0.011	7.1
30–34	10.0 [0.51]	10.7 [0.51]	10.4 [0.55]	9.9 [0.61]	11.5 [0.50]	11.5 [0.45]	11.9 [0.57]	0.31 0.003	19.0
35–44	12.3 [0.32]	12.6 [0.55]	13.2 [0.41]	12.7 [0.34]	12.8 [0.40]	13.8 [0.37]	13.5 [0.52]	0.20 0.037	9.7
45–59	12.9 [0.49]	14.1 [0.40]	14.7 [0.48]	13.7 [0.32]	15.0 [0.39]	14.4 [0.41]	14.4 [0.53]	0.19 0.071	11.6
Education (years)									
0–8	11.3 [0.40]	11.7 [0.50]	12.4 [0.43]	11.5 [0.46]	12.8 [0.39]	12.6 [0.44]	12.7 [0.54]	0.23 0.040	12.3
9–11	9.6 [0.26]	10.0 [0.29]	10.5 [0.31]	10.6 [0.27]	10.9 [0.27]	11.3 [0.23]	11.3 [0.35]	0.28 < 0.001	17.7
12+	9.4 [0.25]	10.0 [0.25]	10.0 [0.30]	9.5 [0.35]	9.9 [0.43]	11.6 [0.26]	10.7 [0.36]	0.25 < 0.001	13.8
Total	10.2 [0.19]	10.7 [0.21]	11.1 [0.22]	10.6 [0.17]	11.2 [0.21]	11.8 [0.20]	11.6 [0.22]	0.23 < 0.001	13.7

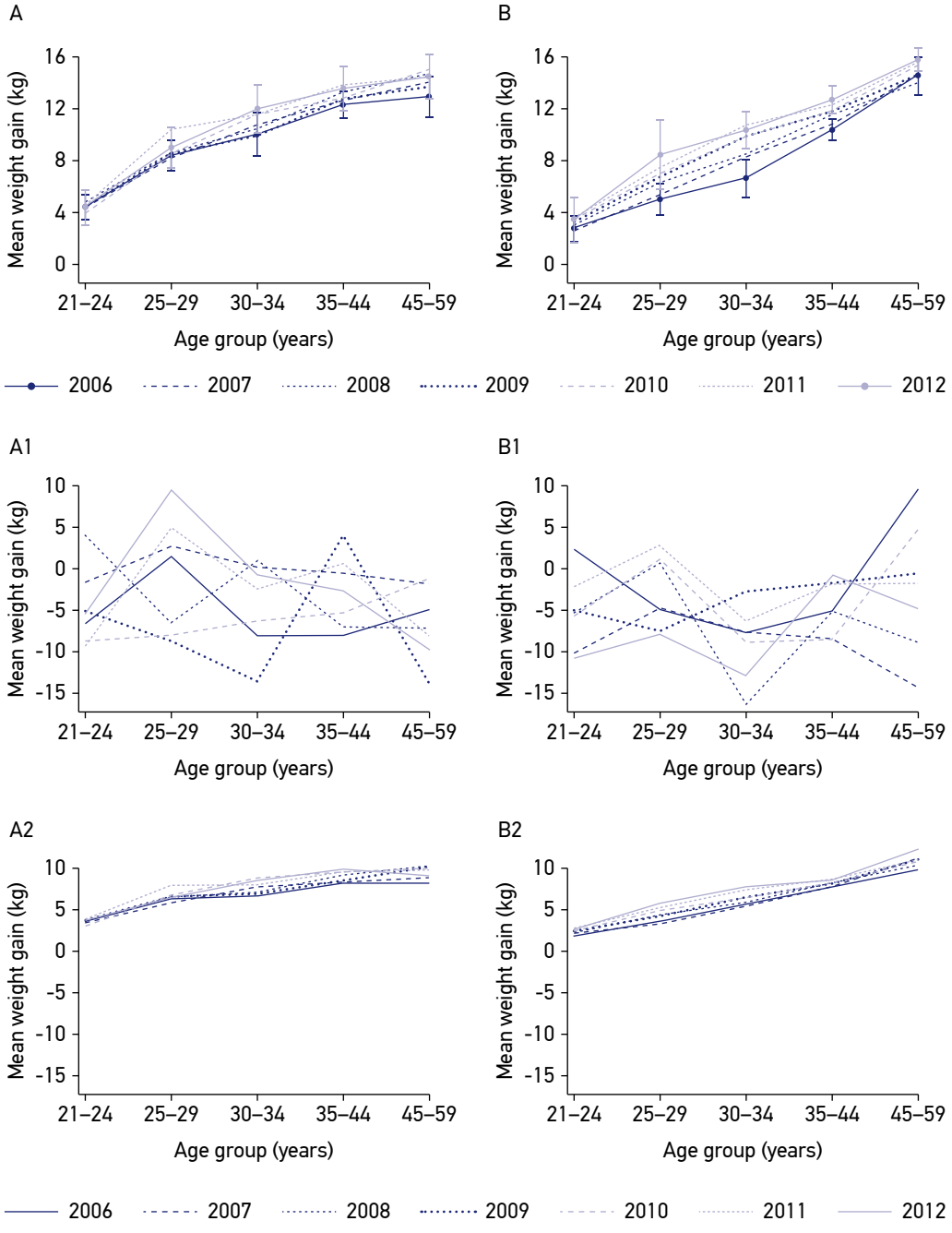
S: South; SE: Southeast; N: North; NE: Northeast; CW: Central-West; SE: standard error; RWC: relative weight change; *generated considering the sample weight; ** relative change in weight gain means.

Tables 3 and 4 show the change in nutritional status after 20 years of age according to sex and age group between 2006 and 2012. Normal weight at 20 years of age was the nutritional state least susceptible to changes with advancing age. Individuals who had a healthy weight at that age were more than 90% likely to remain in that condition until they were 44 years old, regardless of sex and the period analyzed. It is noteworthy that

Table 2. Temporal change in weight gain (kg) in Brazilian women according to region, age range and education. Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), 2006-2012 (n = 110.373).

Sociodemographic variables	2006	2007	2008	2009	2010	2011	2012	B_{YEAR} p	RWC (%)**
	Mean weight gain (kg)* [SE]								
Region									
N/NE/CW	8.3 [0.16]	9.6 [0.12]	10.1 [0.11]	10.4 [0.16]	10.7 [0.16]	11.3 [0.17]	11.5 [0.16]	0.46 < 0.001	38.5
S/SE	9.2 [0.34]	9.4 [0.36]	9.5 [0.28]	10.5 [0.35]	10.8 [0.28]	11.0 [0.18]	11.7 [0.32]	0.42 < 0.001	27.1
Age group (years)									
21–24	2.7 [0.30]	2.5 [0.19]	3.0 [0.28]	3.2 [0.34]	3.5 [0.33]	3.5 [0.32]	3.4 [0.53]	0.16 0.036	25.9
25–29	5.0 [0.36]	5.3 [0.34]	6.3 [0.26]	6.7 [0.47]	7.0 [0.29]	7.4 [0.35]	8.5 [0.81]	0.54 < 0.001	70.0
30–34	6.6 [0.45]	8.3 [0.37]	8.5 [0.28]	9.8 [0.43]	9.8 [0.34]	10.7 [0.34]	10.3 [0.44]	0.57 < 0.001	56.0
35–44	10.3 [0.26]	10.7 [0.28]	11.5 [0.27]	11.8 [0.34]	11.8 [0.30]	12.3 [0.29]	12.7 [0.34]	0.36 < 0.001	23.3
45–59	14.5 [0.44]	14.6 [0.47]	14.0 [0.37]	14.6 [0.33]	15.3 [0.31]	15.6 [0.27]	15.7 [0.27]	0.26 0.001	8.2
Education (years)									
0–8	12.4 [0.48]	12.7 [0.42]	12.5 [0.39]	13.7 [0.52]	14.2 [0.46]	14.4 [0.42]	14.9 [0.46]	0.45 < 0.001	20.1
9–11	8.1 [0.29]	8.6 [0.20]	9.3 [0.21]	10.3 [0.21]	10.2 [0.21]	11.2 [0.22]	11.3 [0.28]	0.54 < 0.001	39.5
12+	6.6 [0.20]	7.0 [0.25]	7.5 [0.27]	7.4 [0.21]	8.6 [0.27]	8.7 [0.22]	9.7 [0.36]	0.49 < 0.001	46.9
Total	8.8 [0.21]	9.5 [0.20]	9.8 [0.16]	10.4 [0.20]	10.7 [0.17]	11.2 [0.13]	11.6 [0.19]	0.44 0.000	31.8

S: South; SE: Southeast; N: North; NE: Northeast; CW: Central-West; SE: standard error; RWC: relative weight change; *generated considering the sample weight; ** relative change in weight gain means.



*The 95% confidence intervals for weight gain means are presented for the years 2006 and 2012; A: men; A1: obese men; A2: non-obese men; B: women; B1: obese women; B2: non-obese women.

Figure 1. Temporal evolution of weight gain (kg) in the Brazilian population according to sex. Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), 2006–2012*.

Table 3. Change in nutritional status after 20 years of age among Brazilian men, according to age group. Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), 2006–2012.

Current BMI		2006–2008 (n = 21.466)						2009–2010 (n = 13.522)						2011–2012 (n = 11.716)					
		Normal weight†*		Overweight‡*		Obesity§*		Normal weight†*		Overweight‡*		Obesity§*		Normal weight†*		Overweight‡*		Obesity§*	
		%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]
21–24 y	Normal weight†	**99.7**	[0.11]	10.3	[1.40]	2.1	[1.27]	**99.9**	[0.09]	13.2	[2.58]	7.2	[2.97]	**99.6**	[0.17]	19.1	[3.95]	4.3	[2.91]
	Overweight‡	0.3	[0.11]	**73.1**	[2.70]	22.2	[5.81]	0.1	[0.09]	**66.4**	[3.99]	23.1	[6.67]	0.3	[0.17]	**60.5**	[4.37]	26.7	[8.42]
	Obesity§	0.0	-	16.6	[2.10]	75.7	[5.93]	0.0	-	20.4	[3.47]	69.7	[6.81]	0.1	[0.02]	20.4	[3.25]	69.0	[9.11]
25–29 y	Normal weight†	**98.7**	[0.42]	9.0	[2.15]	1.5	[0.66]	**99.2**	[0.21]	7.1	[1.71]	11.9	[10.14]	**98.3**	[0.48]	6.5	[1.65]	2.1	[1.19]
	Overweight‡	1.2	[0.42]	54.3	[3.36]	27.2	[6.98]	0.8	[0.21]	54.8	[3.18]	37.3	[9.02]	1.7	[0.48]	57.3	[3.81]	15.8	[5.85]
	Obesity§	0.1	[0.06]	**36.7**	[3.73]	**71.3**	[7.12]	0.0	-	**38.1**	[3.24]	**50.8**	[9.31]	0.0	-	**36.2**	[3.66]	**82.1**	[6.08]
30–34 y	Normal weight†	**97.8**	[0.46]	6.5	[1.76]	5.0	[3.68]	**96.6**	[1.14]	8.5	[2.70]	28.8	[18.01]	**96.3**	[0.86]	8.3	[2.42]	8.5	[5.58]
	Overweight‡	2.1	[0.45]	44.3	[3.21]	25.7	[5.69]	3.3	[1.14]	42.6	[4.02]	29.7	[11.00]	3.3	[0.84]	49.7	[4.72]	9.3	[3.59]
	Obesity§	0.1	[0.02]	**49.2**	[3.19]	**69.3**	[6.27]	0.1	[0.08]	**48.9**	[3.79]	**41.5**	[12.34]	0.4	[0.20]	**42.0**	[3.63]	**82.2**	[6.23]
35–44 y	Normal weight†	**94.3**	[0.75]	11.3	[1.60]	5.2	[2.35]	**93.0**	[1.03]	12.1	[2.21]	5.0	[2.91]	**91.7**	[1.32]	10.6	[2.44]	3.6	[1.71]
	Overweight‡	4.2	[0.55]	39.6	[2.65]	33.6	[7.87]	6.1	[1.03]	35.3	[2.96]	22.7	[5.64]	7.5	[1.34]	37.8	[3.50]	21.3	[5.46]
	Obesity§	1.5	[0.57]	**49.1**	[2.87]	**61.2**	[8.06]	0.9	[0.22]	**52.6**	[3.15]	**72.3**	[6.25]	0.8	[0.26]	**51.6**	[3.57]	**75.1**	[5.47]
45–59 y	Normal weight†	86.0	[1.66]	17.3	[4.08]	8.0	[2.80]	85.9	[2.17]	16.1	[3.00]	16.7	[9.84]	90.2	[1.51]	15.5	[4.55]	11.6	[4.84]
	Overweight‡	11.5	[1.46]	38.6	[3.33]	25.2	[6.32]	11.4	[1.80]	37.6	[3.95]	22.3	[5.77]	7.2	[0.81]	44.0	[4.30]	25.9	[6.37]
	Obesity§	2.5	[1.20]	44.1	[3.47]	66.8	[7.23]	2.7	[0.84]	46.3	[4.07]	61.0	[10.87]	2.6	[0.94]	40.5	[3.83]	62.5	[9.98]

IMC: body mass index; SE: standard error; *after 20 years old; **prevalence with sample weighting; †BMI > 18–24.99 kg/m^2; ‡BMI 25–29.99 kg/m^2; §BMI ≥30 kg/m^2; gray shading indicates direction of change in nutritional status after age 20 (light gray shading: positive anthropometric changes for health; dark gray shading: unfavorable changes for health).

Table 4. Change in nutritional status after 20 years of age among Brazilian women, according to age group. Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), 2006–2012.

Current BMI		2006–2008 (n = 34.054)						2009–2010 (n = 22.504)						2011–2012 (n = 18.691)					
		Normal weight†*		Overweight‡*		Obesity§*		Normal weight†*		Overweight‡*		Obesity§*		Normal weight†*		Sobrepeso‡*		Obesity§*	
		%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[SE]	%**	[r]
21–24 y	Normal weight†	**99.9**	[0.05]	27.9	[4.14]	8.4	[2.66]	**99.5**	[0.18]	29.8	[5.41]	15.8	[6.39]	**99.9**	[0.04]	16.4	[3.13]	5.8	[2.98]
	Overweight‡	0.1	[0.05]	**56.2**	[4.28]	27.2	[7.44]	0.5	[0.18]	**54.5**	[5.55]	21.4	[6.41]	0.1	[0.04]	**57.9**	[5.63]	26.5	[9.39]
	Obesity§	0.0	-	15.9	[3.01]	64.4	[7.33]	0.0	-	15.7	[3.79]	62.8	[6.54]	0.0	-	25.7	[6.01]	67.7	[9.41]
25–29 y	Normal weight†	**99.1**	[0.25]	26.6	[3.57]	11.0	[3.85]	**98.9**	[0.19]	23.6	[4.82]	2.4	[1.17]	**98.2**	[0.39]	15.1	[3.80]	8.4	[3.78]
	Overweight‡	0.8	[0.25]	38.8	[4.74]	32.6	[7.26]	1.0	[0.19]	33.3	[5.98]	29.9	[6.18]	1.6	[0.39]	40.5	[5.62]	32.4	[8.42]
	Obesity§	0.1	[0.04]	**34.6**	[4.87]	**56.4**	[7.19]	0.1	[0.05]	**43.1**	[4.75]	**67.7**	[6.17]	0.2	[0.06]	**44.4**	[5.24]	**59.2**	[8.21]
30–34 y	Normal weight†	**97.9**	[0.31]	20.0	[3.23]	40.3	[11.75]	**97.2**	[0.55]	17.7	[2.91]	10.6	[5.04]	**94.2**	[1.21]	15.3	[3.81]	19.6	[8.05]
	Overweight‡	1.9	[0.31]	26.6	[3.55]	22.3	[8.22]	2.4	[0.52]	26.8	[3.55]	25.6	[8.82]	5.3	[1.20]	28.3	[4.23]	16.8	[5.34]
	Obesity§	0.2	[0.07]	**53.4**	[4.13]	**37.4**	[9.52]	0.4	[0.15]	**55.5**	[4.35]	**63.8**	[9.39]	0.5	[0.24]	**56.4**	[5.91]	**63.6**	[10.09]
35–44 y	Normal weight†	**92.3**	[0.62]	17.5	[2.12]	12.7	[3.93]	**91.5**	[0.70]	17.6	[3.25]	11.4	[3.77]	**91.3**	[0.71]	17.9	[3.45]	9.8	[3.70]
	Overweight‡	6.7	[0.61]	34.5	[3.01]	36.2	[8.96]	7.2	[0.70]	30.9	[3.72]	30.2	[6.89]	7.3	[0.67]	28.3	[2.55]	20.5	[6.19]
	Obesity§	0.9	[0.16]	**48.0**	[2.92]	**51.1**	[8.87]	1.3	[0.21]	**51.5**	[4.19]	**58.4**	[6.85]	1.4	[0.27]	**53.8**	[3.40]	**69.7**	[6.88]
45–59 y	Normal weight†	84.2	[1.14]	26.7	[3.43]	36.2	[9.08]	83.7	[1.18]	19.1	[3.10]	6.6	[2.33]	81.1	[1.35]	13.9	[2.47]	19.7	[4.68]
	Overweight‡	12.3	[0.89]	25.5	[3.56]	15.5	[3.25]	11.2	[0.80]	22.4	[2.84]	22.7	[7.82]	14.5	[1.19]	26.1	[4.10]	19.7	[5.75]
	Obesity§	3.5	[0.48]	47.8	[4.20]	48.3	[9.80]	5.1	[0.72]	58.5	[4.55]	70.7	[7.16]	4.4	[0.73]	60.0	[4.55]	60.6	[6.88]

IMC: body mass index; SE: standard error; *after 20 years old; **prevalence with sample weighting; †BMI > 18–24.99 kg/m^2; ‡BMI 25–29.99 kg/m^2; §BMI ≥30 kg/m^2; gray shading indicates direction of change in nutritional status after age 20 (light gray shading: positive anthropometric changes for health; dark gray shading: unfavorable changes for health).

the probability of remaining normal weight until age 34 was greater than ~ 98% for both sexes (Tables 3 and 4).

On the other hand, changes in relation to overweight and obesity intensified after the period 2006-2008. Of the men interviewed in 2011 and 2012, more than 70% remained obese and less than 5% became normal weight after 20 years old. As for overweight individuals at 20 years, the main direction of the change in nutritional status was towards obesity, where this condition became more frequent with age (Table 3). Specifically for women, there was an acute reduction in overweight from 21–24 years old (57.9%) to 30–59 years old (≥28.3%), suggesting greater volatility for their nutritional status compared to men (Table 4).

DISCUSSION

Using data from the Brazilian adult population residing in the 26 capitals and the DF between 2006 and 2012, we analyzed the weight gain and change in the nutritional status of individuals after the age of 20, examining the temporal variations in these processes. Our results suggested that the main period of weight gain occurred in the first decade after the end of adolescence, decreasing in intensity, but still rising in the subsequent decades, and that during the seven years analyzed, this process grew more intense.

As this study was based on retrospective information, weight at age 20 is subject to memory bias. Given the cumulative effect of this bias among individuals in the older age groups, there might have been a tendency to reporting the weight at 20 years closer to the current weight, which could result in the underestimation of the already high weight variation and the overestimation of agreement between the current nutritional status and that at age 20; in addition, the individual might have reported wrong values. However, although it is unlikely that memory bias did not have an effect on the estimates, the sample size, consistency with the literature and the coherence of the results between the surveys suggest the plausibility of the findings of the present study.

When comparing individuals with and without complete anthropometric information, we did not identify significant differences related to the age group, sex or year of the survey, except in some categories of the macro-region and education variables, in which the sample with anthropometric data showed a lower proportion of individuals in the Northeast Region (23.1 vs. 29.6%) and higher in the South Region (9.6 vs. 5.7%) and respectively lower and higher education between 0–8 years (31.3 vs. 51.1%) and 12 or more years (30 vs. 16%).

Despite these limitations, the main strength of the study was its nationwide (capitals and DF) and temporal representativeness of the adult Brazilian population. In addition, Conde et al.[12] demonstrated the reliability of self-reported anthropometric information in relation to surveys with direct measurement performed by trained and standardized anthropometrists, validating the robustness of the current anthropometric measurement.

Our results reinforce the evidence related to the nutritional transition process, in the perspective that the weight gain process is continuous during adult age cycles, suggesting exposure to environments that promote unhealthy lifestyles[13].

Using Australian surveys (1990, 1995 and 2000), Allman-Farinelli et al.[14] identified that for both sexes, the increase in mean BMI at the time of the survey was positively associated with birth year. A similar result was observed in the American population between 1971–2012, in which there was a tendency not only for mean BMI to increase and obesity to be prevalent in the cohort vector, but also in the age group[15].

Such results are endorsed by cohort studies, as observed by Lima et al.[16], in which there was an increase in the mean and dispersion (on the right) of the BMI in Brazilians aged 15 to 30 years old, born in 1982. In addition, the authors observed a marked increase in the number of individuals who developed an overweight condition (19–20 years: 23.2%; 30–31 years: 57.6%) and obesity (19–20 years: 7.1%; 30– 31 years: 23%) in the first decade after the age of 20. In the comparison between three British birth cohorts (1946, 1958 and 1970), it was noted that the increase in mean BMI in adulthood also occurred in the age and period vectors[17].

It is in childhood that lifestyles begin to take shape, and during adolescence they are consolidated, especially those related to eating behavior, physical activity and other lifestyle habits (for example, smoking and drinking), which may be decisive in maintaining health[18]. Thus, one of the main findings in our study reinforces the strategic role of health promotion during childhood and adolescence, as individuals who started adulthood with healthy weight were more than 90% likely to remain in this condition until the age of 35–44 years old, still remaining high (women: 79.2%; men: 86.8%) until the beginning of older age.

We also noted the difficulty in managing excess weight once reaching that condition, because even with negative mean changes in weight gain among obese individuals at 20, the probability of remaining in this situation throughout life still predominated. There are few studies that consider changes in nutritional status and total weight gain in different age groups. Zheng et al.[13], on the basis of data from two North American cohorts started in 1976 and 1986 (prevalence of overweight >30%), found that the mean (SD) of weight gain between 18 and 55 years of age was 12.6 kg (12.3) and 9.7 kg (9.7) for men and women, respectively. The authors also demonstrated that maintaining adequate weight in the first decades of adulthood was associated with healthy aging. On the other hand, each increase of 5 kg increased the mortality rate and NCDs.

Regarding sex, it was possible to identify that the positive linear temporal trend in weight gain occurred, regardless of the variable analyzed, more substantially in women, which helps in part to understanding the uneven pattern of obesity growth among Brazilian adults in the last decades[3].

From the point of view of events and physiological changes that occurred in adulthood, Nast et al.[19] found that after childbirth, women remain 10 kg heavier or more than before pregnancy. In addition, there is the transition to menopause, in which hormonal changes

may imply an increase of 2 to 2.5 kg every 3 years, with an increase in abdominal fat and a decrease in energy expenditure.

Another essential aspect to understand this process concerns the issue of gender and the complex social influences during the different stages of adulthood. In this sense, considering the period effect (RWC) on weight gain among women with 12 years or more of education, the change in the decade of life in which there was the greatest weigh gain among women may reflect not only the participation of women in the workforce, but their inclusion in positions of higher qualification and pay.

On the one hand, schooling represents a protective factor for overweight, since it is associated with greater access to health services and practicing more self-care (for example, healthier food and physical activity)[20]. On the other, there is the work dynamics of urban centers, with reduced physical work effort, low nutritional quality of meals outside the home and different sources of stress[21-23].

However, it was observed that the women who showed the greatest weight gain after the age of 20 were those with less education. It is possible to speculate that another part of this change in the critical window of weight gain refers to those women who for some reason were unable to/could not finish elementary school[24] (for example, teenage pregnancy, domestic violence, accountability for the family) and needed to enter in low-paying jobs and weak employment ties[25]. At this other extreme, excessive weight gain may result from less access to health information and services, living in unfavorable living conditions for healthy living practices (for example, food deserts, absence of public leisure spaces, crime rate) and being subject to food and nutritional insecurity[26,27]. In addition, Borges et al.[28] identified that Brazilians with lower purchasing power spend a large part of their total income on foods with a high concentration of sugars and fats and that changes in the pattern of shopping to maintain a healthy diet would require a 58% increase in food expenses for families with a per capita income less than or equal to US$ 1/day and 39% for those with per capita income less than or equal to R$ 415/month.

Such considerations reflect a changing society, which would explain to some extent the relatively static pattern in the profile of weight gain among men in the period analyzed, since their position in society is consolidated and is predominant.

Other important aspects to be considered are the sociocultural influence of body image on women, which is influenced by the media and social relations with friends, partners, other women and health professionals, and how a woman's own body image is constructed[29].

It is observed that dissatisfaction with body image is directly associated with dissatisfaction with one's own health, a relationship that is also mediated by unhealthy eating habits and physical inactivity[30]. Such relationships reveal the contradictions present in our society, in which a female biotype of success, beauty and health is commercialized, at the same time that it limits its space in the job market and promotes foods and eating habits and physical activity incompatible with such biotype.

Finally, although there is great appeal about individual choices and behaviors as responsible for obesity, it is an overly simplistic view of the problem and opportunities for intervention,

given its global scope in different life cycles[31]. Thus, there is an urgent need to establish the concept of health in all policies in political and economic decisions in Brazil, to strengthen the regulatory agenda in the production, commercialization and advertising of ultra-processed food products, and to implement the model of care for people with chronic diseases in the Unified Health System and to develop health promotion and social marketing measures, thereby creating favorable environments for the development and maintenance of healthy living habits [31-33].

CONCLUSION

The Brazilian population showed progressive weight gain during adulthood, especially in the first decade after the age of 20. It was also identified that between 2006 and 2012, a positive linear trend in weight gain was considerably more evident in women, resulting in the absolute reduction in differences in weight gain in relation to men. Still, we identified that the effect of low education on weight gain after 20 years was greater among women.

We point out that individuals who reached adulthood with healthy weight showed a strong tendency to remain in this condition until older ages, which shows the importance of public health promotion policies that encourage the development and maintenance of healthy lifestyles still in childhood and adolescence.

REFERENCES

1. NCD Risk Factor Collaboration. Trends in adult body-mass index in 200 countries from 1975 to 2014: A pooled analysis of 1698 population-based measurement studies with 19.2 million participants. Lancet 2016; 387(10026): 1377-96. http://doi.org/10.1016/S0140-6736(16)30054-X
2. James WPT. WHO recognition of the global obesity epidemic. Int J Obes 2008; 32(Supl. 7): S120-6. http://doi.org/10.1038/ijo.2008.247
3. Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares: 2008-2009. Antropometria e Estado Nutricional de Crianças, Adolescentes e Adultos no Brasil. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2010.
4. Brasil. Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Vigilância de Doenças e Agravos não Transmissíveis e Promoção da Saúde. VIGITEL Brasil 2006: Vigilância de Fatores de Risco e Proteção Para Doenças Crônicas Por Inquérito Telefônico. Brasilia: Ministério da Saúde; 2007.
5. Brasil. Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Vigilância de Doenças e Agravos Não Transmissíveis. Vigitel Brasil 2016: Vigilância de Fatores de Risco e Proteção Para Doenças Crônicas Por Inquérito Telefônico: Estimativas Sobre Frequência e Distribuição Sociodemográfica de Fatores de Risco e Proteção Para Doenças Crônicas nas Capitais dos 26 Estados E. Brasília: Ministério da Saúde; 2017.
6. Settersten Jr. RA. Age Structuring and the Rhythm of the Life Course. In: Mortimer JT, Shanahan MJ, eds. Handbook of the Life Course. Nova York: Kluwer Academic Publishers; 2003. p. 728.
7. Matsuzaki M, Kulkarni B, Kuper H, Wells JC, Ploubidis GB, Prabhakaran P, et al. Association of Hip Bone Mineral Density and Body Composition in a Rural Indian Population: The Andhra Pradesh Children and Parents Study (APCAPS). PLoS One 2017; 12(1): e0167114. http://doi.org/10.1371/journal.pone.0167114

8. Department of Health Public Health Research Consortium, Law C, Power C, Graham H, Merrick D. Obesity and health inequalities. Obes Rev 2007; 8(s1): 19-22. http://doi.org/10.1111/j.1467-789X.2007.00312.x
9. Associação Americana de Psiquiatria. Manual Diagnóstico e Estatístico de Transtornos Mentais: DSM-5. Porto Alegre: Artmed; 2014.
10. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development. Genebra: World Health Organization; 2006.
11. WHO WHOEC. Physical Status: The Use and Interpretation of Anthropometry - Report of a WHO Expert Committee. WHO Technical Report Series. Genebra: WHO Library; 1995.
12. Conde WL, Oliveira DR, Borges CA, Baraldi LG. Consistência entre medidas antropométricas em inquéritos nacionais. Rev Saúde Pública 2013; 47(1): 69-76. http://doi.org/10.1590/S0034-89102013000100010
13. Zheng Y, Manson JE, Yuan C, Liang MH, Grodstein F, Stampfer MJ, et al. Associations of weight gain from early to middle adulthood with major health outcomes later in life. JAMA 2017; 318(3): 255-69. http://doi.org/10.1001/jama.2017.7092
14. Allman-Farinelli MA, Chey T, Bauman AE, Gill T, James WPT. Age, period and birth cohort effects on prevalence of overweight and obesity in Australian adults from 1990 to 2000. Eur J Clin Nutr 2008; 62(7): 898-907. http://doi.org/10.1038/sj.ejcn.1602769
15. Kranjac AW, Wagmiller RL. Decomposing trends in adult body mass index, obesity, and morbid obesity, 1971–2012. Soc Sci Med 2016; 167: 37-44. http://doi.org/10.1016/j.socscimed.2016.08.026
16. Lima NP, Horta BL, Motta JV dos S, Valença MS, Oliveira V, Santos VV, et al. Evolução do excesso de peso e obesidade até a idade adulta, Pelotas, Rio Grande do Sul, Brasil, 1982-2012. Cad Saúde Pública 2015; 31(9): 2017-25. http://doi.org/10.1590/0102-311X00173814
17. Bann D, Johnson W, Li L, Kuh D, Hardy R. Socioeconomic Inequalities in Body Mass Index across Adulthood: Coordinated Analyses of Individual Participant Data from Three British Birth Cohort Studies Initiated in 1946, 1958 and 1970. PLoS Med 2017; 14(1): e1002214. http://doi.org/10.1371/journal.pmed.1002214
18. Guo SS, Wu W, Chumlea WC, Roche AF. Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. Am J Clin Nutr 2002; 76(3): 653-8. http://doi.org/10.1093/ajcn/76.3.653
19. Nast M, Oliveira A, Rauber F, Vitolo MR. Ganho de peso excessivo na gestação é fator de risco para o excesso de peso em mulheres. Rev Bras Ginecol Obs 2013; 35(12): 536-40. http://doi.org/10.1590/S0100-72032013001200002
20. Moore CJ, Cunningham SA. Social Position, Psychological Stress, and Obesity: A Systematic Review. J Acad Nutr Diet 2012; 112(4): 518-26. http://doi.org/10.1016/j.jand.2011.12.001
21. Fielden SL, Cooper CL. Managerial Stress: Are Women More at Risk? In: Nelson DL, Burke RJ, eds. Gender, Work Stress, and Health. Washington, D.C.: American Psychological Association; 2002. p. 19-34.
22. Church TS, Thomas DM, Tudor-Locke C, Katzmarzyk PT, Earnest CP, Rodarte RQ, et al. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. PLoS One 2011; 6(5): e19657. http://doi.org/10.1371/journal.pone.0019657
23. Lelis CT, Teixeira KMD, Silva NM da. A inserção feminina no mercado de trabalho e suas implicações para os hábitos alimentares da mulher e de sua família. Saúde Debate 2012; 36(95): 523-32. https://doi.org/10.1590/S0103-11042012000400004
24. Dayrell JT, Jesus RE de. Juventude, ensino médio e os processos de exclusão escolar. Educ Soc 2016; 37(135): 407-23. https://doi.org/10.1590/ES0101-73302016151533
25. Neri M. O Tempo de Permanência Na Escola e as Motivações Dos Sem-Escola. Rio de Janeiro: FGV; 2009.
26. Schlüssel MM, Silva AAM da, Pérez-Escamilla R, Kac G. Household food insecurity and excess weight/obesity among Brazilian women and children: a life-course approach. Cad Saúde Pública 2013; 29(2): 219-41. http://doi.org/10.1590/S0102-311X2013000200003
27. Papas MA, Alberg AJ, Ewing R, Helzlsouer KJ, Gary TL, Klassen AC. The built environment and obesity. Epidemiol Rev 2007; 29(1): 129-43. http://doi.org/10.1093/epirev/mxm009
28. Borges CA, Claro RM, Martins APB, Villar BS. Quanto custa para as famílias de baixa renda obterem uma dieta saudável no Brasil? Cad Saúde Pública 2015; 31(1): 137-48. http://doi.org/10.1590/0102-311X00005114
29. Paquette MC, Raine K. Sociocultural context of women's body image. Soc Sci Med 2004; 59(5): 1047-58. http://doi.org/10.1016/j.socscimed.2003.12.016

30. da Silva P de O, Miguez Nery Guimarães J, Härter Griep R, Melo ECP, Matos SMA, Molina MC, et al. Association between Body Image Dissatisfaction and Self-Rated Health, as Mediated by Physical Activity and Eating Habits: Structural Equation Modelling in ELSA-Brasil. Int J Environ Res Public Health 2018; 15(4): 790. http://doi.org/10.3390/ijerph15040790
31. Swinburn BA, Sacks G, Hall KD, McPherson K, Finegood DT, Moodie ML, et al. The global obesity pandemic: Shaped by global drivers and local environments. Lancet 2011; 378(9793): 804-14. http://doi.org/10.1016/S0140-6736(11)60813-1
32. World Health Organization. Health in All Policies: Helsinki Statement. Framework for Country Action. Genebra: World Health Organization; 2014.
33. World Health Organization. Noncommunicable Diseases Country Profiles 2018. Genebra: World Health Organization; 2018.

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