Original Paper

Annals of Nutrition & Metabolism

Ann Nutr Metab 2016;69:31–40
DOI: 10.1159/000447363

Received: September 21, 2015
Accepted: May 23, 2016
Published online: July 20, 2016

Nutritional Status Associated to Skipping Breakfast in Brazilian Health Service Patients

Gislaine Cândida Batista-Jorge[a] Antônio Sérgio Barcala-Jorge[a]
Anderson Frederico Oliveira Dias[b] Marise Fagundes Silveira[a]
Deborah de Farias Lelis[a] João Marcus Oliveira Andrade[a] Rafael Moreira Claro[d]
Alfredo Mauricio Batista de Paula[a] Andre Luiz Sena Guimaraes[a]
Adaliene Versiane Ferreira[d] Sérgio Henrique Sousa Santos[a, c]

[a]Laboratory of Health Science, Postgraduate Program in Health Sciences, Universidade Estadual de Montes Claros (UNIMONTES), [b]Department of Medicine, Faculdades Integradas do Norte de Minas Gerais (FUNORTE), [c]Institute of Agricultural Sciences, Food Engineering College, Universidade Federal de Minas Gerais (UFMG), Montes Claros, and [d]Department of Nutrition, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Key Words
Skipping breakfast · Obesity · Healthy lifestyle · Physical activity

Abstract
Recent studies show that skipping breakfast is associated with an increased risk of obesity, diabetes and cardiovascular diseases. In this context, this study evaluated 400 patients from the Brazilian health service who had their nutritional status defined based on the body mass index and were classified as physically active or insufficient active. The energy intake and macronutrients was also assessed by a 24-hour dietary recall where the association of overweight/obesity with the investigated variables was evaluated using chi-square, Student's t test and multivariate analysis ($p < 0.05$). The main results showed that more than half of the studied population have the habit of omitting breakfast (55.8%), and among those, 81.2% were overweight/obese ($p < 0.0001$). Almost three-fourths of these individuals consumed no more than 4 meals a day (73.0%), and regarding this meal frequency/day, 78.8% of the individuals who reported having 4 meals or less a day were overweight/obese compared with 57.8% who reported as having 5–6 meals/day ($p < 0.0001$). The individuals who reported to omit breakfast had a higher chance of being overweight compared with those who had this habit (OR 2.20; 95% CI 1.40–3.60) and the chance of the physically insufficient active individuals to be overweight/obese was 2.9 times higher when compared to the active individuals ($p < 0.0001$). Our findings suggest that regular breakfast consumption may decrease overweight and obesity risk.

Introduction

According to the World Health Organization (WHO), obesity has more than doubled since 1980 [1]. In 2014, more than 1.9 billion adults were overweight and over 600

KARGER

E-Mail karger@karger.com
www.karger.com/anm

0250–6807/16/0691–0031$39.50/0

Sérgio Henrique Sousa Santos
Institute of Agricultural Sciences
Food Engineering College, Universidade Federal de Minas Gerais (UFMG)
Avenida Universitária, 1000, Universitário, Montes Claros, MG 39404-547 (Brazil)
E-Mail sergiosousas@hotmail.com

million were obese. This increasing prevalence of obesity may be explained by several factors, including genetic predisposition, nutrition and lifestyle [2–4]. Although the genetic factors are not the main direct cause of obesity, they increase the individual's susceptibility to develop this condition and contribute in 25–70% of the cases [5, 6]. The epigenetic factors also play an important role in the development of obesity, especially because the main characteristic that triggers the fat accumulation is the imbalance between energy intake and energy expenditure [7]. The energy imbalance that have been associated with the genesis of obesity may be explained by the recent changes observed in the population's dietary patterns, which includes an increasing intake of energy-dense food products, caloric beverages (such as soft drinks) and processed food products, besides the diminished frequency of physical activity observed nowadays [8, 9].

The provision of energy and nutrients throughout the day is extremely important for a good energy homeostasis. In this sense, breakfast is considered one of the 3 main meals to be held during the day and it is defined as the first meal you have once you wake up [10, 11]. With that in mind, it is essential to highlight the importance of the breakfast meal as an important dietary factor for energy regulation [12]. Recent studies have been showing that individuals who eat breakfast commonly have a lower body mass index (BMI) when compared to those who are breakfast skippers [13]. Additionally, several other studies also show that skipping breakfast is associated with overweight and obesity [13–18].

The present study aimed to address the association between omitting breakfast and the presence of overweight/obesity, by controlling demographic characteristics, habits and behaviors, and anthropometric (BMI and waist circumference, WC), nutritional and biochemical/clinical parameters retrieved from Brazilian health service patients.

Methods

Study Design and Population

This is a cross-sectional study, where the association between the habit of having breakfast and the presence of overweight/obesity, along with other parameters, such as demographic characteristics, habits and behavior and anthropometric, nutritional and biochemical/clinical were evaluated. All data were retrieved from Brazilian health service patients.

This study was conducted in the ambulatory of the Nutrition Clinic/Tancredo Neves Ambulatory Specialties Center – CAETAN/Universidade Estadual de Montes Claros – UNIMONTES located in Montes Claros, Minas Gerais, Brazil. The individuals included in the study were the patients attending the Lifestyle Changing Program – 'Nutrition and Health' – in the period from January 2013 to December 2014. All the individuals are employees of the Universidade Estadual de Montes Claros who were interested in participating in the 'Nutrition and Health Program', which is aimed to improve the quality of life of the employees, changes of habit and lifestyle, by focusing in the dietary reeducation. These patients constitute a universe of 2,400 UNIMONTES employees.

The sample size was defined considering the following parameters: percentage of 50% for overweight/obesity occurrence, level of confidence of 95% and an error rate of 5%. The calculations evidenced the need to evaluate 384 patients. For the patient selection, a nonprobability sampling was applied, being considered the spontaneous demand of the patients who requested the Clinical Nutrition Service. The inclusion criteria were age superior to 18 years, the absence of pregnancy and not have been submitted to bariatric surgery.

Additionally, in this study, individuals undergoing treatment for dyslipidemia, hypertension (self-reported use of antihypertensive medication) or diabetes were automatically classified as presenting those conditions.

Subjects gave their written consent to participate in the study, which was approved by the Ethics Committee of the Universidade Estadual de Montes Claros, by the process number 152337.

Anthropometric Measurements

Body weight was measured in kilograms in an electronic scale Balmak, Model BK-50FA (minimum capacity of 1 kg and a maximum of 150 kg, sensitivity of 50 g and calibrated by the Institute of Weights and Measures). In order to standardize the weighing, the participants were weighed in typical indoor clothing without shoes. The height (m) was determined to the nearest 0.1 cm, with the participants standing upright against an aluminum stadiometer (Model BK-50FA), coupled to the scale (maximum capacity of 200 cm, with intervals of 0.5 cm, without shoes).

The overall nutritional status was defined based on the BMI, according to the WHO [19]. Epidemiologic studies generally use the BMI, which is calculated with the body weight and height (weight (kg)/height (m^2)), as an indicator of body weight excess and obesity. Furthermore, the international definitions of overweight and obesity in adults are based on the BMI as the body weight, and height can be measured in a relatively simple and precise manner. However, the BMI does not predict the body composition directly and since obesity refers to an increase in the body adiposity, the underlying assumption of using the BMI to define obesity is that at a given height, an elevated weight is associated with increased fat.

However, partly because of the limitations of BMI, the use of other simple measures to assess adiposity, such as WC or the ratio of waist–hip, has also been suggested [20].

Having said that, in this study, the individuals were classified in the following groups: normal weight as BMI >18.5 and <25 kg/m^2, overweight as BMI ≥25 and <30 kg/m^2 and obese as BMI ≥30 kg/m^2. The participants included in the groups overweight and obese were grouped in one unique group as follows: overweight/obese (BMI ≥25 kg/m^2) [19].

The WC was obtained using an inelastic tape, with a scale of 0.5 cm placed without pressure in the horizontal plane at the smallest circumference between the bottom of the last rib and the iliac

crest [21–23]. The WC was classified as increased when ≥80 cm for women and ≥94 cm for men, and very increased when ≥88 cm for women and ≥102 cm for men [22].

Biochemical Measurements

The serum levels of fasting glucose, total cholesterol, high-density lipoprotein (HDL) cholesterol (HDL-c), low-density lipoprotein cholesterol (LDL-c) and triglycerides (TG) were measured by using specific enzymatic Elisa kits (DSA BioELISA, USA) [18]. The individuals were previously advised to not perform vigorous physical exercises 24 h and/or consume alcohol 72 h prior to blood collection.

The cutoffs recommended by Brazilian Guideline for Dyslipidemia and Atherosclerosis prevention were the following: total cholesterol ≥200 mg/dl (high) <200 mg/dl (normal), TG ≥150 mg/dl (high) <150 mg/dl (normal), LDL-c ≥160 mg/dl (high) <100 mg/dl (normal) and HDL-c <40 mg/dl (men) and <50 mg/dl (women) (lowered). The determination of dyslipidemias involves changes in isolation or together of the 4 measured parameters [24].

The glycemia cutoffs were considered as follows: fasting plasma glucose (FPG) <100 mg/dl (normal) and from 100 to 125 mg/dl as identifying individuals with prediabetes and FPG ≥126 mg/dl as identifying individuals with diabetes (abnormal) [25].

Nutrition Assessment

The evaluation of energy intake and macronutrients (carbohydrates, proteins and lipids) was performed by a 24-hour dietary recall (24HDR; online suppl. material, see www.karger.com/doi/10.1159/000447363) [14]. This strategy allowed us to identify the times and meal consumption frequency (breakfast, morning snack, lunch, snack, dinner and optional meal), the amount consumed of each food item (in household measures) [26] and details of feeding behavior. For the ingested caloric surplus calculations, the total caloric value (TCV)/day was assessed taking into consideration the formula of 30 kcal/kg/day considering the ideal body weight [27].

Based on two 24HDR data [26], the food items consumed in each meal were identified and converted in nutrients and calories using the software 'Nutrition Support Program/version 2.5/Medical School of São Paulo'. However, due to the occurrence of numerous regional consuming products, some foods had to be added using the Brazilian Table of Food Composition [28].

Individuals were classified as breakfast skippers based on the habit of omitting the breakfast meal for at least 5 days/week [29]. Nutritional status was defined by a joint analysis of clinical diagnosis, food habits identified in the food anamnesis and especially by anthropometry, having BMI as the main factor [30]. A dietitian single trained examiner performed the evaluation of all the parameters.

Physical Activity Assessment

For the physical activity evaluation, the classification described by the WHO was adopted [31], using the following criteria: adults aged 18–64 years should do at least 150 min of moderate-intensity aerobic physical activity throughout the week or of at least 75 min of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity. Thus, in our article, the variable was categorized as 'active' for individuals who meet this criteria and 'insufficient active' for those who do not meet.

Statistical Analysis

Individuals participating in the study were described according to their demographic characteristics, food consumption habits, behavior and nutritional status. The association of overweight/obesity with the investigated variables was assessed using the chi-square test for the categorical variables and the Mann–Whitney U test for the numeric variables that did not present normal distribution. The normality of these numeric variables was assessed by the Kolmogorov–Smirnov test.

Variables with descriptive level (p value) no greater than 0.25 in bivariate analysis were included in the multivariate analysis using logistic regression models. The regression models considered the overweight/obese status as the dependent variable and the habit of having breakfast as the independent variable. All the other variables were treated as confounding variables. Brute and adjusted ORs (with their respective CI of 95%) were estimated. The significance level at this stage was 0.05, and the Hosmer–Lemeshow test was used to assess the model's fit quality. All analyzes were performed using Predictive Analytics Software (PASW) version 17.0 for Windows software.

Results

Sociodemographic Characteristics

A total of 409 patients requested the Clinical Nutrition Service, and out of these, 9 did not attend the inclusion criteria (5 pregnant and 4 patients submitted to bariatric surgery). Therefore, 400 patients were enrolled in the study, 73.5% of those being overweight/obese. The majority of the individuals were women (80.2%). Regarding the gender, the larger number of women included in this study may be explained by the spontaneous demand of women to this kind of services, such as nutritional assistance, and by the fact that women are usually more motivated to care for their body and health [32, 33]. Concerning the age, 52.6% of the individuals were aged from 18 to 40 years, the mean age for women was 40.2 (SD 9.9) years (min 19; max 60) and 38.4 (SD 10.2) years for men (min 24; max 56). However, despite the higher percentage of women on the sample, the average age of both genders showed no significant differences when evaluated by Student's t test ($p = 0.148$). In his study, we adopted only the level of schooling as the socioeconomic indicator, since each level corresponds to a specific income range in the salary path of the Universidade Estadual de Montes Claros where the individuals work. For this parameter, it was observed that 94.6% of the individuals were classified as having technical or higher schooling degree (table 1). The distribution of the further sociodemographic characteristics is present in the table 1.

Regarding the association between overweight/obese and the sociodemographic characteristics, higher chances of being overweight/obese were observed for female

Table 1. Distribution, proportion and ratio of brute chances of overweight/obesity by the variables investigated

Variables	Total, %	Overweight/ obesity, %	Normal weight, %	OR_b (95% CI)	p value*
Demographic characteristics					
Sex					0.020
Male	79 (19.8)	70.4	29.6	1.00	
Female	321 (80.2)	83.5	16.5	2.13 (1.12–4.05)	
Age, years					0.026
Until 29	61 (15.3)	59.0	41.0	1.00	
30–40	149 (37.3)	73.8	26.2	1.96 (1.05–3.67)	
41–50	117 (29.2)	73.5	26.5	1.93 (1.00–3.71)	
51–60	73 (18.2)	82.2	17.8	3.21 (1.46–7.04)	
Shooling					0.309
Fundamental	22 (5.4)	71.5	28.5	1.00	
Technical	115 (28.8)	73.9	26.1	1.13 (0.69–1.85)	
Higher	263 (65.8)	86.4	13.6	2.53 (0.73–8.79)	
Marital status					0.007
Single	240 (60.0)	65.6	34.4	1.00	
Married	160 (40.0)	77.9	22.1	1.85 (1.18–2.89)	
Work shift					0.974
Daytime	353 (88.3)	73.1	26.9	1.00	
Night shift	30 (7.5)	73.3	26.7	1.01 (0.44–2.35)	
Daytime/night shift	17 (4.2)	70.6	29.4	0.88 (0.30–2.58)	
Habits and behavior					
Breakfast					<0.0001
Eating	177 (44.3)	62.7	37.3	1.00	
Omitting	223 (55.8)	81.2	18.8	2.56 (1.63–4.03)	
Meals (daily)					<0.0001
5–6	108 (27.0)	57.8	42.2	1.00	
2–4	292 (73.0)	78.8	21.2	2.75 (1.71–4.20)	
Physical activity					<0.0001
Active	90 (22.5)	53.3	46.7	1.00	
Insufficient active	310 (77.5)	78.7	21.3	3.24 (1.97–5.31)	
Alcohol consumption					0.964
No	213 (53.5)	72.8	27.2	1.00	
Yes	185 (46.5)	73.0	17.0	1.01 (0.65–1.57)	
Anthropometric parameters					
BMI, kg/m^2					
Normal weight	106 (26.5)	–	–	–	
Overweight	148 (37.0)	–	–	–	
Obesity	146 (36.5)	–	–	–	
WC*					<0.0001
Normal	252 (63.3)	59.5	40.5	1.00	
Central adiposity	146 (36.7)	97.9	2.1	32.4 (10.1–104.5)	
Waist–hip ratio					<0.0001
Normal	225 (65.2)	64.7	35.3	1.00	
Increased	136 (34.8)	90.4	9.6	5.16 (2.76–9.66)	
Nutritional parameters					
Excess caloric, %					<0.0001
Up to 10	74 (18.5)	48.6	51.4	1.00	
10–20	52 (13.0)	63.5	36.5	1.83 (0.89–3.79)	
Above 20	274 (68.5)	81.4	18.6	4.61 (2.67–7.98)	
TCV, mean ± SD	2,418.9±454.2	2,532.6±441.7	2,103.4±320.5	1.03 (1.02–1.04)	<0.0001
Lipids, %, mean ± SD	30.5±4.5	30.4±4.8	31.0±3.4	0.96 (0.91–1.02)	0.962
Carbohydrates, %, mean ± SD	53.3±6.9	53.5±7.4	52.5±5.2	1.03 (0.99–1.06)	0.180

Table 1. (continued)

Variables	Total, %	Overweight/ obesity, %	Normal weight, %	OR_b (95% CI)	p value*
Biochemical and clinical parameters					
HDL*					0.023
Normal	165 (45.8)	67.3	32.7	1.00	
Lowered	195 (54.2)	77.9	22.1	1.72 (1.08–2.75)	
LDL*					0.747
Normal	204 (57.8)	74.0	26.0	1.00	
High	149 (42.2)	72.5	27.5	0.93 (0.57–1.49)	
Total cholesterol					0.452
Normal	193 (52.9)	71.5	28.5	1.00	
High	172 (47.1)	75.0	25.0	1.20 (0.75–1.91)	
TG					<0.0001
Normal	225 (63.0)	65.8	34.2	1.00	
High	132 (37.0)	85.6	14.4	3.09 (1.77–5.41)	
Fasting glycemia					0.019
Normal	289 (79.2)	70.9	29.1	1.00	
Abnormal	76 (20.8)	84.2	15.8	2.19 (1.12–4.26)	
AH					<0.0001
No	268 (67.2)	64.2	35.8	1.00	
Yes	131 (32.8)	90.8	9.2	5.54 (2.91–10.54)	

BMI = Body mass index; WC = waist circumference; TCV = total caloric value; HDL = high-density lipoprotein; LDL = low-density lipoprotein; TG = triglycerides; AH = arterial hypertension; CI = confidence interval; SD = standard-deviation. Interval of 95% confidence. * $p < 0.05$; the totals were due to the lack of information.

individuals (OR 2.30, p = 0.013), patients over 50 years (OR 3.0, p = 0.009) and civil state married (OR 1.60, p = 0.050; fig. 1).

Habits and Behavior

More than half of the studied population did not have the habit of having breakfast (55.8%) and almost three-fourths of them consume no more than 4 meals a day (73.0%). Concerning the physical activity practice, 77.5% were considered insufficient active and 53.5% declared no consumption of alcohol (table 1).

It was verified that 81.2% of the individuals who did not have the habit of having breakfast were overweight/obese. Regarding meal frequency/day, 78.8% of the individuals who reported having 4 meals or less a day were overweight/obese as compared with 57.8% who reported as having 5–6 meals/day ($p < 0.0001$). Furthermore, 78.7% of the individuals who were considered insufficient active were overweight/obese as compared to the 53.3% overweight/obese individuals who were physically active (table 1).

In the multiple analysis, when the model was adjusted by gender, age, marital status and physical activity, association statistically significant between the habit of omitting breakfast and overweight/obesity was observed (OR 2.20, p = 0.001), as well as the level of physical activity that was also found to be associated with overweight/obesity (OR 2.90, $p < 0.0001$), where the chance of the insufficient active individuals to be overweight/obese was 2.9 times higher as compared to active individuals (fig. 1).

Anthropometric and Nutrition Parameters

In the study cohort, 26.5% of the individuals presented normal weight, 37.0% were overweight and 36.5 were obese. Regarding the analysis of WC, 36.7% were classified as having central adiposity, and 97.9% of these individuals were also classified in the overweight/obese group (table 1). Among the 294 who were overweight/obese, 48.8% presented central adiposity, and among the 106 individuals with normal weight, 2.9% also presented central adiposity. However, when the individuals with central adiposity and the individuals who did not have central adiposity were evaluated regarding overweight and obesity separately, the following frequencies were observed: 36.9% overweight individuals, 18.5% individuals with central adiposity and among the 36.8% with obesity,

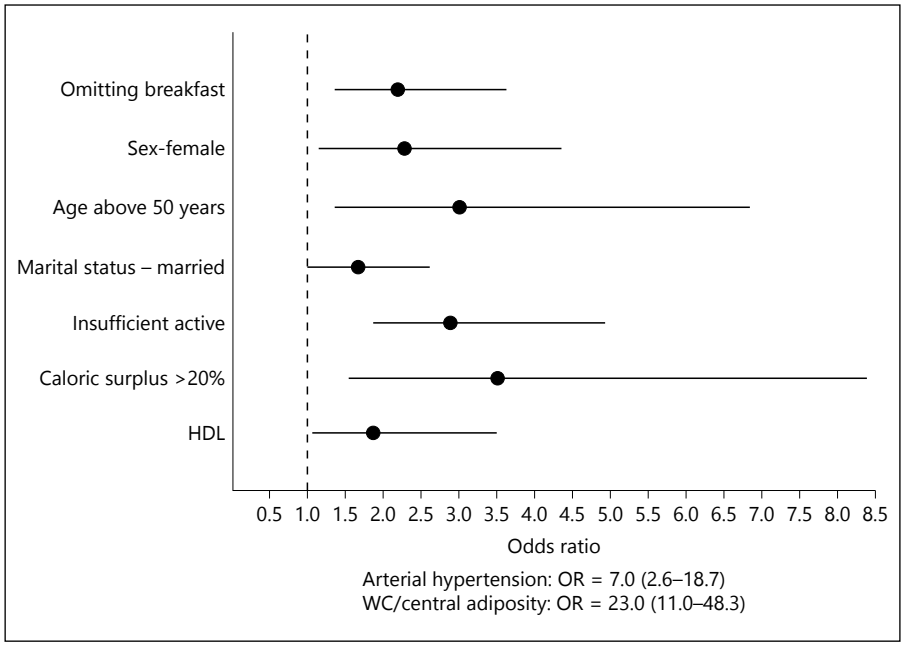

Fig. 1. Association (OR) between the regular breakfast and overweight/obesity adjusted for demographic characteristics, habits and behavior, anthropometric, nutritional, biochemical and clinical parameters: omitting breakfast (OR 2.20, p = 0.001), female gender (OR 2.30, p = 0.013), age above 50 years (OR 3.0, p = 0.009), marital status – married (OR 1.60, p = 0.050), insufficient active (OR 2.90, p < 0.0001), caloric excess above than 20% (OR 3.90, p = 0.004), low HDL levels (OR 1.90, p = 0.039), AH (OR 7.0, p < 0.0001) and WC (central adiposity; OR 23.01, p < 0.0001) are factors associated with obesity.

79.5% presented central adiposity. Thus, when the overweight or obese individuals were evaluated separately, it was observed that not all overweight individuals present normal WC, but the majority of them did (n = 120).

The caloric excess (above 20%) of the nutritional/day requirements was observed in 68.5% of the assessed individuals. The TCV average found was 2,418.4 kcal/day (SD 454.2). Regarding macronutrients balancing, the lipid average was 30.5% (SD 4.5) and carbohydrates 53.3% (SD 6.9; table 1).

In the adjusted analysis (fig. 1), higher chances of being overweight/obese were observed among the patients with central adiposity (OR 23.01, p < 0.0001), and the patients with excessive caloric intake, greater than 20% (OR 3.9, p = 0.004). Regarding the association between the total caloric intake and the nutritional status of the individuals evaluated, a statistically significant association was also observed (p < 0.0001) in the bivariate analysis (table 1). However, in the adjusted analysis, there was no statistically significant association between this variable and the nutritional status (fig. 1).

Additionally, among the individuals who skip breakfast, 81, 40 and 38% presented overweight/obesity, central adiposity and ratio of waist–hip, respectively (fig. 2). Figure 3 also display the CI for the total calorie intake mean as compared to the habit of having breakfast, where it is verified with a significant difference between the means of these values.

Biochemical, Nutrition and Clinical Analysis

Concerning the biochemical parameters in the bivariate analysis, associations between overweight/obesity and the serum levels of HDL (p = 0.023), TG (p < 0.0001), glucose (p = 0.019) and arterial hypertension (AH, p < 0.0001) were observed (table 1). However, when the adjusted analysis were applied, an association between overweight/obesity only with the variables HDL (OR 1.90, p = 0.039) and AH (OR 7.00, p < 0.0001) were observed (fig. 1).

Discussion

Obesity, Nutrition Habits and Behavior

This study collaborates with the comprehension about the relation between breakfast and overweight/obesity in developing countries [34]. Breakfast is considered 1 of the 3 main meals to be held during the day [29, 35] and should represent the recommended 25% energy content of the TCV to be consumed in a day [29, 36, 37].

The dietary pattern modifications, including the energy restriction, are a challenge in the prevention and treatment of obesity worldwide. Thus, the comprehension that the dietary habits are associated with a reduced intake of energy is important to optimize the obesity management [38–40]. In this sense, the consumption of breakfast may be considered a good habit. The breakfast

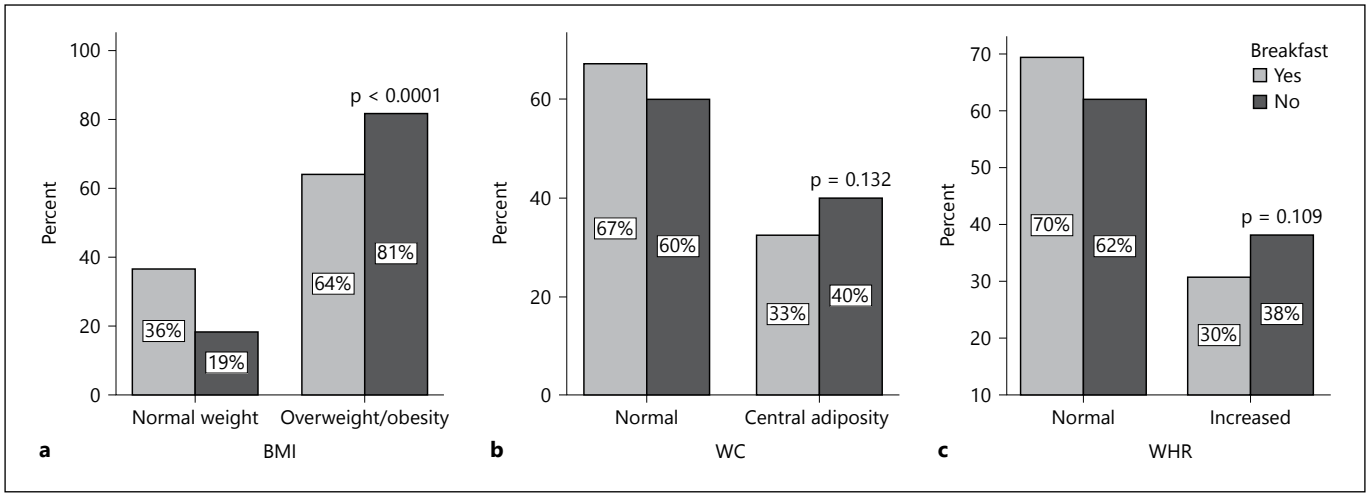

Fig. 2. Analysis of the association between the habit of having or omitting breakfast and the BMI, WC and waist–hip ratio (WHR). **a** Eighty one percent of the individuals with overweight/obesity were breakfast skippers ($p < 0.0001$); **b** 40% of the individuals that presented abdominal obesity did not have the habit of having breakfast; **c** 38% of the individuals with altered waist–hip ratio were also breakfast skippers.

benefits have been studied, especially regarding its omission by some individuals [38, 41]. However, it is not clear if the regular breakfast consumption is associated to a daily lower total energy intake [16].

Previous studies reported that breakfast skippers have a higher energy intake during the day than breakfast eaters [11, 18, 42], and this increased energy intake may be associated with the current eating behavior changes [18, 22]. Therefore, this study evidenced an association between the habit of skipping breakfast with obesity and a higher total calorie intake, which can be understood as a metabolism compensation [38, 43], as the individual eats more calories during the day to compensate the lack of breakfast [9, 44]. This process may facilitate the intake of excessive calories, which was observed in this study and corroborated by previous studies [12, 18] providing evidence that skipping breakfast is not an effective way to manage weight [45].

A study performed with diabetes type 2 adults demonstrated that a recommended strategy to decrease the daily consumption of energy is to eat a higher proportion of this energy in the breakfast. It seems that the energy given in the breakfast in absolute, might be correlated with opposite results, directly reflecting in the energy intake in the following meals and consequently in the daily energy consumption [46].

In addition, it may be understood that not only the habit of having breakfast might influence the total daily calorie intake, but also the nutritional content of this meal regarding the presence of macronutrients, fibers content and total energy density.

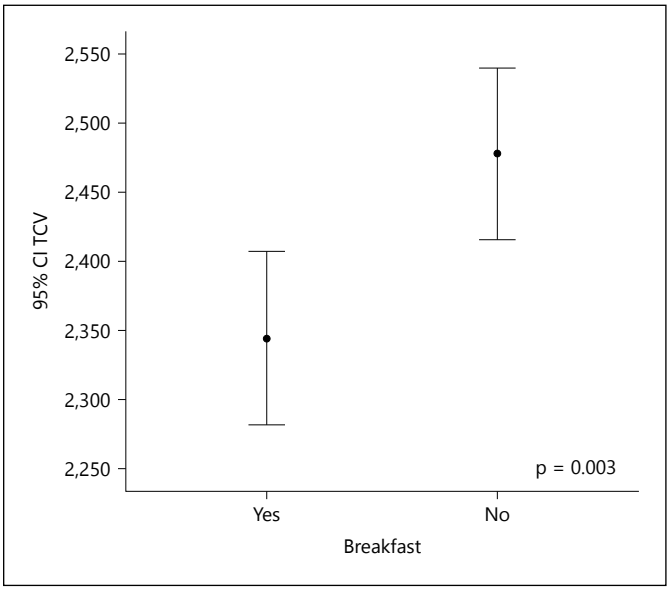

Fig. 3. Analysis of the association between the habit of having or omitting breakfast and the total calorie value (TCV). The group of individuals who had the habit of having breakfast presented a decreased TCV compared to the individuals who omit breakfast ($p = 0.003$).

Furthermore, as confirmed in a randomized clinical trial [12], eating breakfast reduces impulsive snacks and thus, a large reduction in calories and fats intake. An ex-

planation could be that the increased tardy food intake causes weight gain. During the morning period, the body energy expenditure is less likely to happen and is consequently stored when the breakfast is skipped [18]. On the other hand, controlled studies showed that although skipping a meal reduced fat oxidation, it was reported that there is a trend arguing that a 6 meals/day pattern improve appetite control when compared to a 3 meals/day pattern. Consequently, reducing eating frequency to 3 meals/day may hinder the appetite control [17].

Our study found an association between skipping breakfast and high BMI measurements, corroborating with NHANES and protocols that showed that 37.2 and 25.9% of the juvenile adults (19–29 years) and adults (30–39 years), respectively, had the habit of omitting breakfast [14]. Previous studies performed by the same author evidenced an association between lower BMI and the habit of having breakfast, especially in women [40]. Additionally, in another study in a cohort of US men, breakfast consumption was found to be inversely associated with risk of 5 kg weight gain [47].

Additionally, a cross-sectional study performed with 693 Minnesota adolescents showed an inverse relationship between BMI and consumption of breakfast [48]. Another association found in our study regards the higher values of BMI and higher values of WC (central adiposity) in individuals who do not have breakfast in a daily basis. This finding, corroborates with a recent longitudinal study that followed children by over 24 years and reported an association between skipping breakfast and several parameters, such as WC, blood markers of insulin and LDL-c and higher levels of BMI [42].

Breakfast: Biochemical and Clinical Parameters

Concerning the habit of having a regular breakfast, our findings showed a significant correlation between the basal glucose levels and the prevalence of overweight/obesity, corroborating with other studies that shows that breakfast consumption can improve postprandial glycemic response and insulin sensitivity [12, 42], decrease the appetite and contribute to weight control. As obesity is considered a risk factor for several chronic diseases, such as cardiovascular diseases [14] and diabetes mellitus, the correlation between skipping breakfast and the development of insulin resistance deserves more attention in molecular studies [29, 41].

Skipping meals is an important cause of a decrease in the overall consumption of calories, which results in blood glucose level spikes. The omission of breakfast can cause a decrease in serum blood glucose concentrations, resulting in the activation of the gluconeogenic pathway, thus causing the disarrangement of the muscle tissue with the goal of providing glucose for the brain [14, 18]. This may lead to a decrease in physical strength, which may cause a decrease in the basal metabolism, explained by the loss of muscle volume. Moreover, the starvation state may cause the conservation of energy by limiting physical activities, which can result in a condition where the body does not lose weight but gains weight easily instead [18].

The present study identified a higher chance of the obese breakfast skippers achieve clinical conditions such as AH and low levels of HDL-c as well the excess calorie intake habit. A study by Cahill et al. [44] showed that men who skipped breakfast had a 27% higher chance of developing coronary heart disease as compared with men who did not. Furthermore, in another study, it was shown that the presence of breakfast was associated with an improvement of the cardiometabolic risk in young individuals, suggesting a protective role for breakfast [14]. A study performed by Timlin and Pereira [11] also demonstrate that the frequency of breakfast consumption is strongly and inversely associated with the risk to develop obesity in the long term. Thus, breakfast consumption might be a mechanism to reduce the risks to develop metabolic syndrome, diabetes type 2 and hypertension. In this sense, it is suggesting other impacts for the breakfast consumption, not only in the adiposity, but also probably in the glycemic, insulin and lipid metabolism control.

Obesity, Breakfast Consumption and Physical Activity

Concerning physical activity, this study found a significant association between the practice of physical activity and overweight/obesity. Regular breakfast skipping has been generally reported to be associated with a sedentary lifestyle and unhealthy diet consumption [42, 49]. Furthermore, skipping breakfast can cause not only a decrease in physical activities in the morning but also a decrease in the total energy expenditure that can result in the development of obesity [18].

The main contribution of this study is to emphasize the importance of the daily consumption of breakfast that plays important roles in obesity associated factors, such as appetite, hormonal, glycemic, insulin and lipid metabolism control. Indeed, the regular habit of consuming breakfast, as well as its nutritional content, will result in significant independent effects on total energy intake, dietary content, metabolic control and consequently balance the weight control. These aspects, along with a lifestyle change, will contribute preventively for the prevalence reduction of obesity worldwide.

In conclusion, our results suggest that the regular consumption of breakfast might reduce the risks of overweight\obesity development, especially when associated to the practice of physical activity. However, further studies are necessary to elucidate the direct association between obesity and the regular consumption of breakfast.

Disclosure Statement

The authors declare that they have no conflicts of interest. This review was undertaken as part of self-funded MD study.

Acknowledgments

This work was supported by the Universidade Estadual de Montes Claros (Unimontes), Montes Claros, Minas Gerais, Brazil. The authors appreciate the university personnel for their cooperation in collecting the data.

The present work was supported in part by grants from Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG – Brazil), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq – Brazil), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES – Brazil) and by the Universidade Estadual de Montes Claros (Unimontes), Montes Claros, Minas Gerais, Brazil. The authors appreciate the university personnel for their cooperation in collecting the data.

References

1 WHO: Obesity and Overweight. World Health Organization, 2015.
2 Kushner RF, Ryan DH: Assessment and lifestyle management of patients with obesity: clinical recommendations from systematic reviews. JAMA 2014;312:943–952.
3 Santos SH, Simoes e Silva AC: The therapeutic role of renin-angiotensin system blockers in obesity-related renal disorders. Curr Clin Pharmacol 2014;9:2–9.
4 Santos SH, Andrade JM: Angiotensin 1-7: a peptide for preventing and treating metabolic syndrome. Peptides 2014;59:34–41.
5 Hill JO, Melanson EL: Overview of the determinants of overweight and obesity: current evidence and research issues. Med Sci Sports Exerc 1999;31:S515–S521.
6 Ponterio E, Gnessi L: Adenovirus 36 and obesity: an overview. Viruses 2015;7:3719–3740.
7 Campion J, Milagro F, Martinez JA: Epigenetics and obesity. Prog Mol Biol Transl Sci 2010;94:291–347.
8 Wijtzes AI, Jansen W, Jaddoe VW, Franco OH, Hofman A, van Lenthe FJ, Raat H: Social inequalities in young children's meal skipping behaviors: the generation R study. PLoS One 2015;10:e0134487.
9 Kapantais E, Chala E, Kaklamanou D, Lanaras L, Kaklamanou M, Tzotzas T: Breakfast skipping and its relation to BMI and health-compromising behaviours among Greek adolescents. Public Health Nutr 2011;14:101–108.
10 Hoyland A, Dye L, Lawton CL: A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. Nutr Res Rev 2009;22:220–243.
11 Timlin MT, Pereira MA: Breakfast frequency and quality in the etiology of adult obesity and chronic diseases. Nutr Rev 2007;65(6 pt 1):268–281.
12 Chowdhury EA, Richardson JD, Tsintzas K, Thompson D, Betts JA: Carbohydrate-rich breakfast attenuates glycaemic, insulinaemic and ghrelin response to ad libitum lunch relative to morning fasting in lean adults. Br J Nutr 2015;114:98–107.
13 Chung SJ, Lee Y, Lee S, Choi K: Breakfast skipping and breakfast type are associated with daily nutrient intakes and metabolic syndrome in Korean adults. Nutr Res Pract 2015;9:288–295.
14 Deshmukh-Taskar P, Nicklas TA, Radcliffe JD, O'Neil CE, Liu Y: The relationship of breakfast skipping and type of breakfast consumed with overweight/obesity, abdominal obesity, other cardiometabolic risk factors and the metabolic syndrome in young adults. The national health and nutrition examination survey (NHANES): 1999–2006. Public Health Nutr 2013;16:2073–2082.
15 Croezen S, Visscher TL, Ter Bogt NC, Veling ML, Haveman-Nies A: Skipping breakfast, alcohol consumption and physical inactivity as risk factors for overweight and obesity in adolescents: results of the E-MOVO project. Eur J Clin Nutr 2009;63:405–412.
16 Levitsky DA, Pacanowski CR: Effect of skipping breakfast on subsequent energy intake. Physiol Behav 2013;119:9–16.
17 Leidy HJ, Campbell WW: The effect of eating frequency on appetite control and food intake: brief synopsis of controlled feeding studies. J Nutr 2011;141:154–157.
18 Watanabe Y, Saito I, Henmi I, Yoshimura K, Maruyama K, Yamauchi K, Matsuo T, Kato T, Tanigawa T, Kishida T, Asada Y: Skipping breakfast is correlated with obesity. J Rural Med 2014;9:51–58.
19 WHO: Global Database on Body Mass Index. World Health Organization, 2006.
20 Flegal KM, Shepherd JA, Looker AC, Graubard BI, Borrud LG, Ogden CL, Harris TB, Everhart JE, Schenker N: Comparisons of percentage body fat, body mass index, waist circumference, and waist-stature ratio in adults. Am J Clin Nutr 2009;89:500–508.
21 Holanda LG, Martins Mdo C, Souza Filho MD, Carvalho CM, Assis RC, Leal LM, Mesquita LP, Costa EM: [Overweight and abdominal fat in adult population of Teresina, PI]. Rev Assoc Med Bras 2011;57:50–55.
22 Chinedu SN, Ogunlana OO, Azuh DE, Iweala EE, Afolabi IS, Uhuegbu CC, Idachaba ME, Osamor VC: Correlation between body mass index and waist circumference in Nigerian adults: implication as indicators of health status. J Public Health Res 2013;2:e16.
23 Ashwell M, Gunn P, Gibson S: Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obes Rev 2012;13:275–286.
24 Sposito AC, Caramelli B, Fonseca FA, Bertolami MC, Afiune Neto A, Souza AD, Lottenberg AM, Chacra AP, Faludi AA, Loures-Vale AA, Carvalho AC, Duncan B, Gelonese B, Polanczyk C, Rodrigues Sobrinho CR, Scherr C, Karla C, Armaganijan D, Moriguchi E, Saraiva F, Pichetti G, Xavier HT, Chaves H, Borges JL, Diament J, Guimaraes JI, Nicolau JC, dos Santos JE, de Lima JJ, Vieira JL, Novazzi JP, Faria Neto JR, Torres KP, Pinto Lde A, Bricarello L, Bodanese LC, Introcaso L, Malachias MV, Izar MC, Magalhaes ME, Schmidt MI, Scartezini M, Nobre M, Foppa M, Forti NA, Berwanger O, Gebara OC, Coelho OR, Maranhao RC, dos Santos Filho RD, Costa RP, Barreto S, Kaiser S, Ihara S, Carvalho TD, Martinez TL, Relvas WG, Salgado W: [IV Brazilian guideline for dyslipidemia and atherosclerosis prevention: department of atherosclerosis of Brazilian society of cardiology]. Arq Bras Cardiol 2007;88(suppl 1):2–19.
25 American Diabetes Association: (2) Classification and diagnosis of diabetes. Diabetes Care 2015;38(suppl):S8–S16.
26 de Oliveira Santos R, Fisberg RM, Marchioni DM, Troncoso Baltar V: Dietary patterns for meals of Brazilian adults. Br J Nutr 2015;114:822–828.
27 Garita FS, Cukier C: Manual Prático em Terapia Nutricional, ed 1, 2010.
28 UNICAMP: Tabela Brasileira de Composição de Alimentos (TACO), ed 2. Campinas, UNICAMP, 2006.

29 Uemura M, Yatsuya H, Hilawe EH, Li Y, Wang C, Chiang C, Otsuka R, Toyoshima H, Tamakoshi K, Aoyama A: Breakfast skipping is positively associated with incidence of type 2 diabetes mellitus: evidence from the Aichi workers' cohort study. J Epidemiol 2015;25:351–358.
30 Mesas AE, Munoz-Pareja M, Lopez-Garcia E, Rodriguez-Artalejo F: Selected eating behaviours and excess body weight: a systematic review. Obes Rev 2012;13:106–135.
31 WHO: Global Recommendations on Phisical Activity for Health, 2010.
32 Bertakis KD, Azari R, Helms LJ, Callahan EJ, Robbins JA: Gender differences in the utilization of health care services. J Fam Prac 2000;49:147–152.
33 Redondo-Sendino A, Guallar-Castillon P, Banegas JR, Rodriguez-Artalejo F: Gender differences in the utilization of health-care services among the older adult population of Spain. BMC Public Health 2006;6:155.
34 Musaiger A, Kalam F: Dietary habits and lifestyle among adolescents in Damascus, Syria. Ann Agric Environ Med 2014;21:416–419.
35 Farshchi HR, Taylor MA, Macdonald IA: Deleterious effects of omitting breakfast on insulin sensitivity and fasting lipid profiles in healthy lean women. Am J Clin Nutr 2005;81:388–396.
36 Affenito SG: Breakfast: a missed opportunity. J Am Diet Assoc 2007;107:565–569.
37 Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD: Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. J Am Diet Assoc 2005;105:743–760; quiz 761–762.
38 Sun J, Yi H, Liu Z, Wu Y, Bian J, Wu Y, Eshita Y, Li G, Zhang Q, Yang Y: Factors associated with skipping breakfast among inner Mongolia medical students in China. BMC Public Health 2013;13:42.
39 Betts JA, Richardson JD, Chowdhury EA, Holman GD, Tsintzas K, Thompson D: The causal role of breakfast in energy balance and health: a randomized controlled trial in lean adults. Am J Clin Nutr 2014;100:539–547.
40 Cho S, Dietrich M, Brown CJ, Clark CA, Block G: The effect of breakfast type on total daily energy intake and body mass index: results from the third national health and nutrition examination survey (NHANES III). J Am Coll Nutr 2003;22:296–302.
41 Mekary RA, Giovannucci E, Cahill L, Willett WC, van Dam RM, Hu FB: Eating patterns and type 2 diabetes risk in older women: breakfast consumption and eating frequency. Am J Clin Nutr 2013;98:436–443.
42 Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ: Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the childhood determinants of adult health study. Am J Clin Nutr 2010;92:1316–1325.
43 Deshmukh-Taskar PR, Nicklas TA, O'Neil CE, Keast DR, Radcliffe JD, Cho S: The relationship of breakfast skipping and type of breakfast consumption with nutrient intake and weight status in children and adolescents: the national health and nutrition examination survey 1999–2006. J Am Diet Assoc 2010;110:869–878.
44 Cahill LE, Chiuve SE, Mekary RA, Jensen MK, Flint AJ, Hu FB, Rimm EB: Prospective study of breakfast eating and incident coronary heart disease in a cohort of male US health professionals. Circulation 2013;128:337–343.
45 Dhurandhar EJ, Dawson J, Alcorn A, Larsen LH, Thomas EA, Cardel M, Bourland AC, Astrup A, St-Onge MP, Hill JO, Apovian CM, Shikany JM, Allison DB: The effectiveness of breakfast recommendations on weight loss: a randomized controlled trial. Am J Clin Nutr 2014;100:507–513.
46 Jarvandi S, Schootman M, Racette SB: Breakfast intake among adults with type 2 diabetes: is bigger better? Public Health Nutr 2015;18:2146–2152.
47 van der Heijden AA, Hu FB, Rimm EB, van Dam RM: A prospective study of breakfast consumption and weight gain among U.S. men. Obesity (Silver Spring) 2007;15:2463–2469.
48 So HK, Nelson EA, Li AM, Guldan GS, Yin J, Ng PC, Sung RY: Breakfast frequency inversely associated with BMI and body fatness in Hong Kong Chinese children aged 9–18 years. Br J Nutr 2011;106:742–751.
49 Garcia Milla P, Candia Johns P, Duran Agueros S: [Association between breakfast intake and quality of life among self-sufficient Chilean elderly]. Nutr Hosp 2014;30:845–850.