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Hierarchical Analysis of The Factors Associated with the Consumption of Fruits and Vegetables: Cohort of Universities of Minas Gerais, Brazil (Cume Project)

Moreira MA[1], Moreira APB[1], Hermsdorff HHM[2], Pimenta AM[3], Bressan J[2], Candido APC*[1]

[1]Department of Nutrition, Institute of Biological Sciences and Graduate Program in Public Health, Department of Public Health, School of Medicine, Federal University of Juiz de Fora – UFJF, Juiz de Fora, MG, Brazil

[2]Department of Nutrition and Health, Federal University of Vicosa – UFV, Vicosa, MG, Brazil

[3]Department of Nursing, Federal University of Parana – UFP, Curitiba, PR, Brazil

***Corresponding Author:** Candido APC, Department of Nutrition, Institute of Biological Sciences, Federal University of Juiz de Fora – UFJF, Jose Lourenco Kelmer St., Campus Universitario, Sao Pedro, Juiz de Fora, MG, 36036-900, Brazil. Tel: +55 (32) 991066906. Email: anapaula.candido@ufjf.edu.br

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Abstract

The objective of this study was to assess which factors, at hierarchical levels, are associated with adequate consumption of fruits and vegetables (FV) in undergraduate and graduate students. This is a cross-sectional analysis of the baseline of the Cohort of Universities of Minas Gerais (CUME Project), with alumni from Universities of Minas Gerais, Brazil, in the years 2016 and 2018. The outcome variable was adequate consumption of FV (≥400 g/day). The exposure variables were divided into: block 1, socioeconomic (marital status, education, professional status, individual and family income); block 2, behavioral (physical activity, alcohol consumption, tobacco use, and consumption of legumes, natural juices, ultra-processed foods, soft drinks and industrialized juices, and fast foods); block 3, individual (gender, age, skin color, self-perception of health and presence of obesity, systemic arterial hypertension, diabetes mellitus, and depression). To verify the associations, hierarchical multiple logistic regression was used. The sample consisted of 4,124 individuals with a median age of 34 years and Interquartile Range (IQ) of 12 years, 68.1% women, with a high frequency (62.2%) of adequate consumption of FV. This adequate consumption of FV was associated with being a woman (OR=1.41; 95%CI 1.21-1.64; p<0.001), advancing in age and being physically active (OR=2.10; 95%CI 1.78-2.47; p<0.001), having regular consumption of natural fruit juice (OR=2.00; 95%CI 1.70-2.34, p<0.001), or consumption of ultra-processed foods (OR=0.96; 95%CI 0.95-0.97; p<0.001). In conclusion, individual and behavioral factors are associated with adequate consumption of FV in highly educated individuals.

Keywords: Food Consumption, Fruits and Vegetables, Social Determinants of Health, Regression Analysis

List of Abbreviations

FV: fruits and vegetables.
WHO: World Health Organization.
DGBP: Dietary Guidelines for the Brazilian Population.
Vigitel: surveillance of risk and protective factors for chronic diseases by telephone survey.
CUME: Cohort of Universities of Minas Gerais.
Q_0: baseline questionnaire.
UFV: Federal University of Vicosa.
UFMG: Federal University of Minas Gerais
UFJF: Federal University of Juiz de Fora.
UFLA: Federal University of Lavras.
UFOP: Federal University of Ouro Preto.
FFQ: Food Frequency Questionnaire.
ICC: Intraclass Correlation Coefficient.
MW: minimum wage.
BMI: Body Mass Index.
PAHO: Pan American Health Organization.
SAH: Systemic Arterial Hypertension.
DM: Diabetes Mellitus.
POF: Pesquisa de Orcamentos Familiares.
IQ: interquartile range.
CI: confidence interval.

Introduction

The adequate consumption of fruits and vegetables (FV), according to the World Health Organization (WHO), is 400 grams per day to obtain the benefits for health and nutrition [1]. In order to raise people's awareness of these benefits and the importance of adequate consumption of fruit and vegetables for a healthy diet and lifestyle, 2021 was declared the International Year of Fruits and Vegetables [2]. The Dietary Guidelines for the Brazilian Population (DGBP) also emphasizes the importance of including FV in the main meals of the day, with illustrations and recommendations that support and encourage this adequate consumption [3].

In this context, promoting actions concerning this topic is extremely important for public health, since the consumption of FV is below the recommendations in most of the population [4]. In Brazil, inadequate intake of FV occurred in 77.5% of the population in the data presented by the surveillance of risk and protective factors for chronic diseases by telephone survey (Vigitel) in 2020 for adults in Brazil [5].

Evidence confirms that a diet with higher consumption of FV is associated with a lower risk of mortality, especially mortality from cardiovascular disease [6,7]. It is also suggested that inadequate consumption of FV was the cause of 3.9 million deaths worldwide in 2017 [8]. Many factors can be associated with FV consumption [9,10]. Therefore, in addition to investigating the adequate or inadequate consumption of FV, it is also important to assess which factors this consumption is associated with, in order to support more effective and targeted interventions.

Within this context, the objective of this study was to evaluate which factors, at hierarchical levels, are associated with adequate consumption of FV, in baseline participants of the Cohort of Universities of Minas Gerais – CUME Project.

Materials and Methods

CUME Project and Study Sample

This is a cross-sectional study with baseline data from the Cohort of Universities of Minas Gerais, CUME Project, from the questionnaires applied in 2016 and 2018. The CUME Project, with alumni from Federal Universities in the State of Minas Gerais, Brazil, studies the impact of the Brazilian population's dietary patterns, for food groups and specific dietary factors, on the development of non-communicable diseases and conditions in these participants [11]. Data collection took place online. All participants read and agreed to the online free and informed consent form.

In 2016, the CUME Project baseline questionnaire (Q_0) was completed by participants from the Federal University of Vicosa (UFV) and the Federal University of Minas Gerais (UFMG). In 2018, in addition to graduates from UFV and UFMG who did not participate in 2016, participants from the Federal University of Juiz de Fora (UFJF), the Federal University of Lavras (UFLA), and the Federal University of Ouro Preto (UFOP) also responded. The Q_0 was divided into two steps, answered with an interval of one week. The first stage included sociodemographic, anthropometric and lifestyle characteristics, and issues related to the individual's health. The second stage included a Food Frequency Questionnaire (FFQ).

The final sample evaluated in this study had 4,124 participants. In order to compose this sample, inclusion criteria (complete Q_0, both sexes, and age greater than or equal to 20 years) and exclusion criteria (non-Brazilian nationality (n=26), individuals who did not reside in Brazil in the last year (n=173), pregnant women and women who had a child in the year before the questionnaire was applied (n=172), total energy consumption with inconsistent values [<500 kcal/day (n = 2) or >6,000 kcal/day (n = 129)]) [12].

It is noteworthy that this research was guided by Resolution 466/12 of the National Health Council, which covers the ethical aspects involved in research with human beings, under the opinion number of the Ethics Committee on Research involving human beings of the institutions involved 596.741-0/2013 (UFV), 2.491.386 (UFMG), 2.615.738 (UFJF), and 2.565.240 (UFOP).

Adequate Consumption of FV

Food consumption was assessed using a FFQ validated for the participants of this cohort [13], with 135 food items, which can be consulted on the CUME project website (www.projetocume.com.br), in the "questionnaire" tab. The FFQ was presented to participants in eight groups (dairy products, meat and fish, cereals and legumes, fruits, vegetables, fats and oils, beverages, other foods), in which each participant had to select which foods they consumed in the last year. Then, with the help of a photo album, the participants selected the size of the portions in traditional measures (unit, slices, and pieces) or household measures commonly used by Brazilians (teaspoon, tablespoon, ladle, pinch, tong, saucer, cup, and glass) and the frequency of consumption (from one to nine or more) as units of time (day, week, month, or year).

Subsequently, the consumption of each food item from the FFQ was transformed into a daily frequency and multiplied by the indicated portion (in g or mL). To quantify nutrients and energy (kcal), the Brazilian Food Composition Table [14] and the US Department of Agriculture Table [15] were used.

The FV consumption was calculated as the sum of the fruit and vegetable groups (g/day): avocado, pineapple, acai, acerola, banana, guava, kiwi, orange/tangerine, apple/pear, papaya, mango, watermelon, melon, strawberry/cherry, peach/plum/nectarine, grape, raisin, tropical fruit (pitanga, mangosteen, soursop, umbu, cupuacu), fruit salad, pumpkin/squash, zucchini/chayote, lettuce/chard, cress/kale/arugula/spinach/chicory, cassava/yam/baroa potato (cooked), fried cassava, baked potato, French fries, beets (raw/cooked), eggplant, carrots (raw/cooked), cauliflower/cabbage, corn, cucumber, peppers (red/green), green beans, tomato, and vegetable soup indicated in the FFQ by the participants. It should be noted that in the validation, the FFQ showed moderate general agreement [all items evaluated: Intraclass Correlation Coefficient (ICC) = 0.44] and specifically (fruits: ICC = 0.62, vegetables: ICC = 0.42) [13].

Adequate consumption of FV, the outcome variable (categorical, dichotomous), was considered FV consumption equal to or greater than 400 grams per day [1].

Theoretical Model

The exposure variables were divided into three blocks in order to compose a hierarchical conceptual model, based on the literature [9-10.16-18]: Block 1, socioeconomic factors, Block 2, behavioral factors, and Block 3, individual factors, represented in "Figure 1".

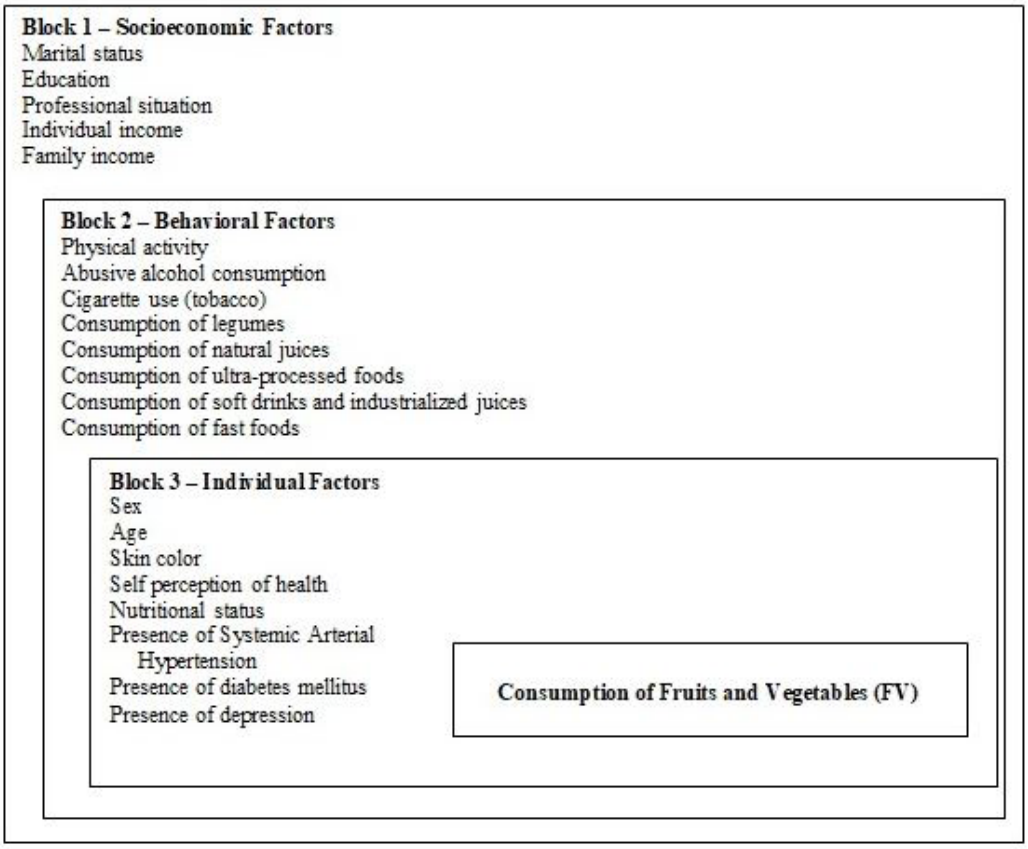

Figure 1: Hierarchical explanatory model of consumption of fruits and vegetables in baseline participants of the Cohort of Universities of Minas Gerais - CUME Project, 2016, 2018.

Starting with the variables of Block 1, marital status was divided into "Single", "Married or in a stable union", "Separated", "Widowers and Others". When classifying education, all were graduates due to the characteristics of the study participants, therefore, it was divided into "Graduate", "Specialization", "Master's", "Doctorate and/or Post-Doctorate". Professional status was divided into "Works" (has formal full-time or part-time work or informal work), "Student", "Retired and/or Housewives" and "Unemployed". Individual and Family Income were divided into multiples of the minimum wage (MW) in force in the year the questionnaire was answered (R$880, in 2016, R$954, in 2018), based on incomes reported in the questionnaire as continuous values. In addition, they were classified into incomes of "up to 5xMW", incomes between "5xMW and 10xMW" and incomes "equal to or greater than 10xMW". Considering the variables of Block 2, the practice of physical activity was divided into "Active", "Insufficiently active" or "Inactive". Inactive individuals were those who did not practice any physical activity, insufficiently active individuals were those who practiced less than 150 minutes/week of moderate-intensity activity or less than 75 minutes/week of vigorous-intensity activity, while active individuals were those who practiced leisure-time physical activity of at least 150 minutes/week of moderate-intensity activity or at least 75 minutes/week of vigorous-intensity activity [19]. Heavy episodic consumption of alcohol (binge drinking) was considered alcohol consumption of 4 doses or more and 5 doses or more in the same day for females and males, respectively [20]. Cigarette use (tobacco) was divided into "yes" or "no", according to self-report whether the individual currently "smokes", even if occasionally, or "no", if the individual does not currently use tobacco.

The food consumption variables included in block 2 are markers of a healthy diet, such as the consumption of legumes (beans and lentils) and the consumption of natural fruit juices, as well as markers of an unhealthy diet, such as the consumption of ultra-processed foods, consumption of soft drinks and industrialized juices, and consumption of fast foods [9,21]. The consumption of legumes, natural juices, soft drinks and processed juices were considered regular when the frequency of consumption was daily, and the consumption of fast foods was considered regular when the frequency of consumption was weekly. Consumption of ultra-processed foods was assessed by the relative frequency (%) of daily (continuous) caloric intake. The other foods were categorized as "yes" (regular consumption) and "no" (non-regular consumption), in which the frequency information of the FFQ was used.

Regarding the variables in Block 3, gender was answered as female or male. Age was answered as a natural number, and classified into age groups: "20 - 29 years", "30 - 39 years", "40 - 49 years", "50 - 59 years", "≥ 60 years". Skin color was answered as white, black, brown, yellow, or indigenous and classified as "white", "black/brown" and "yellow/indigenous". Self-reported Health Status, an important indicator that represents both physical and emotional components of individuals, as well as aspects of well-being and satisfaction with one's own life [22], was categorized as: "Very good", "Good", "Fair", "Bad/Very Bad". Body Mass Index (BMI) was calculated from weight (in kg) divided by height (in meters) squared (Weight/Height2). For BMI classification, the values established by the WHO (1998) [23] for adults were used (Low weight: <18.5 kg/m2, Eutrophy: 18.5 to 24.9 kg/m2, Overweight: 25.0 to 29.9 kg/m2, Obesity: ≥ 30.0 kg/m2) and the values of the Pan American Health Organization (PAHO) (2002) [24] for the elderly (Low weight: ≤ 23.0 kg/m2, Eutrophy: 23.1 to 27.9 kg/m2, Overweight: 28.0 to 29.9 kg/m2, Obesity: ≥ 30.0 kg/m2). Systemic Arterial Hypertension (SAH) was considered present if the participant met any of the following criteria: systemic blood pressure greater than or equal to 130 mmHg and/or diastolic blood pressure greater than or equal to 80 mmHg [25], use of antihypertensive medication, positive report of medical diagnosis of hypertension (high blood pressure). Diabetes Mellitus (DM) was considered present if the participant met any of the following criteria: fasting serum glucose greater than or equal to 126 mg/dL [26], use of antidiabetic medication and/or insulin, positive report of medical diagnosis of diabetes. Depression was considered present only by the positive report of a medical diagnosis of depression. Furthermore, it is noteworthy that the data on weight, height, BMI, systolic blood pressure, diastolic blood pressure, and fasting serum glucose were validated [27].

Statistical Analysis

The database was created using Stata software, version 13.0 and exported to SPSS software, version 21.0 for statistical analyses. To verify the factors associated with the consumption of FV, SPSS, version 21.0 was used, starting with univariate logistic regression analysis. Subsequently, the variables that presented statistical significance in the univariate analysis of less than 20% ($p<0.20$) were selected for multiple logistic regression analysis.

In the multivariate analysis, the hierarchical entry of variables in blocks [28] was adopted, in the following order: Block 1 socioeconomic variables, Block 2: behavioral variables, Block 3: individual variables, so that the conceptual model used for the hierarchy of variables was built and maintained during data analysis, allowing for variables more strongly associated with the outcome, using the backward LR method [28,29].

For interpretation of the results, an association of $p<0.05$ was considered statistically significant. Explanatory power was evaluated using the Nagelkerke R Square test and the consistency of the final model's fit was evaluated using the Hosmer-Lemeshow test (the fit being considered adequate when $p<0.05$).

Results

The study presented a sample of 4,124 participants. Regarding the outcome variable, 62.2% (n=2,565) of the participants had adequate consumption of FV (equal to or greater than 400 grams per day).

Considering the socioeconomic factors, these can be observed in the absolute (n) and relative (%) frequency columns of "Table 1". The sample showed similar percentages for participants with marital status of single (45.8%, n=1,887) and married or in a stable union (48.1%, n=1,982), followed by 4.8% (n=198) and 1.4% (n=57) for separated marital status and "widowers/others", respectively. The participants' minimum education was undergraduate, considering specialization, master's, doctoral and post-doctoral degrees, 72.5% of participants have graduate degrees, with master's the most frequent graduate degree (29%, n=1,195). Most participants work (75.8%, n=3,127) full-time, part-time, and/or informally. The median individual income of the population in this study was R$4,781.06 and an interquartile range (IQ) of R$5,118.23, with 47.6% (n=1,965) having an income of up to 5xMW. The median family income was R$8,000.00 (IQ: 7,000.00), and a large part of the sample had a family income above 10xMW (45.5%, n=1,875).

"Table 1" also shows the associations of socioeconomic factors with the outcome, showing that all variables in Block 1 were associated with adequate consumption of FV in univariate analysis.

BLOCK 1 - SOCIOECONOMIC FACTORS						
Variable	n	(%)	Adequate Consumption of FV (%) †	OR	(95% CI)	p-value
Marital Status						
Single	1887	(45.8)	57.1	1		
Married/Stable Union	1982	(48.1)	65.7	1.26	(1.27-1.64)	<0.001‡
Separated	198	(4.8)	72.2	1.41	(1.41-2.70)	<0.001‡
Widower/Others	57	(1.4)	73.7	1.16	(1.16-3.82)	<0.001‡
Education						
University graduate	1136	(27.5)	57.0	1		
Specialization	991	(24.0)	66.6	1.50	(1.26-1.79)	<0.001‡
Master's degree	1195	(29.0)	60.6	1.16	(0.98-1.36)	0.082‡
Doctorate/Post-Doc	802	(19.5)	66.5	1.49	(1.24-1.80)	<0.001‡
Professional situation						
Works §	3127	(75,8)	63.2	1		
Student	628	(15,2)	56.4	0.75	(0.63-0.90)	0.001‡
Retired/Housewives	97	(2,4)	83.5	2.95	(1.72-5.07)	<0.001‡
Unemployed	272	(6,6)	57.0	0.77	(0.60-0.99)	0.044‡
Individual Income						
≤ 5xMW	1965	(47,6)	58.9	1		
Between 5xMW and 10xMW	1442	(35,0)	62.8	1.18	(1.02-1.35)	0.021‡
≥ 10xMW	717	(17,4)	69.9	1.62	(1.35-1.94)	<0.001‡
Family Income						
≤ 5xMW	884	(21,4)	58.5	1		
Between 5xMW and 10xMW	1365	(33,1)	60.4	1.09	(0.91-1.29)	0.356
≥ 10xMW	1875	(45,5)	65.2	1.33	(1.13-1.57)	0.001‡

† Adequate consumption of fruits and vegetables: consumption equal to or greater than 400g per day (World Health Organization).

§ Full/Part-time and/or Informal work

MW, minimum wage (R$880.00 in 2016, R$954.00 in 2018).

OR, Odds Ratio. 95% CI, 95% confidence interval.

Univariate Logistic Regression.

‡ $p < 0.20$, variable included in the formation of the final hierarchical model.

Table 1: Univariate analysis model between socioeconomic factors and adequate consumption of fruits and vegetables (dependent variable), in baseline participants of the Cohort of Minas Gerais Universities - CUME Project, 2016, 2018.

Descriptive behavioral factors can be observed in the absolute (n) and relative (%) frequency columns of "Table 2". Most participants were active (55.8%, n=2,301), did not report abusive alcohol consumption (58.4%, n=2,409), and did not smoke (91.4%, n=3,769).

Regarding food consumption, 61.6% (n=2,541) of participants reported regular consumption of legumes, 28.4% (n=1,172) regular consumption of natural fruit juices, 14.0% (n=577) regular consumption of fast foods, and 15.3% (n=630) regular consumption of soft drinks and industrialized juices. The relative energy consumption of ultra-processed foods presented a mean of 24.5% (95% CI 24.1-24.8).

"Table 2" also shows the associations of the behavioral variables described above with adequate consumption of FV. Of these variables, all were associated with the outcome, highlighting a positive association with physical activity, consumption of legumes, consumption of natural fruit juice, and a negative association with abusive consumption of alcohol, cigarette use, relative consumption of ultra-processed foods, consumption of fast foods, soft drinks, and industrialized juices.

BLOCK 2 - BEHAVIORAL FACTORS						
Variable	n	(%)	Adequate Consumption of FV (%) †	OR	(95% CI)	p-value
Physical Activity						
Inactive	990	(24.0)	50.4	1		
Insufficiently active	833	(20.2)	60.5	1.51	(1.26-1.82)	<0.001‡
Active	2301	(55.8)	67.9	2.08	(1.79-2.42)	<0.001‡
Binge Drinking [a]						
No	2409	(58.4)	63.9	1		
Yes	1715	(41.6)	59.8	0.84	(0.74-0.96)	0.055‡
Cigarette use (tobacco)						
No	3769	(91.4)	62.6	1		
Yes	355	(8.6)	57.5	0.81	(0.65-1.00)	<0.001‡
Consumption of legumes [b]						
No	1583	(38.4)	58.6	1		
Yes	2541	(61.6)	64.5	1.28	(1.13-1.46)	<0.001‡
Consumption of natural juices [c]						
No	2952	(71.6)	56.9	1		
Yes	1172	(28.4)	75.5	2.33	(2.00-2.72)	<0.001‡
Relative consumption (%) of ultra-processed foods						
(Mean: 24.5% – 95% CI: 24.1-24.8)				0.95	(0.94-0.95)	<0.001‡
Consumption of fast foods [d]						
No	3547	(86.0)	63.6	1		
Yes	577	(14.0)	53.7	0.66	(0.56-0.79)	<0.001‡
Consumption of soft drinks and industrialized juices						
No	3494	(84.7)	63.2	1		
Yes	630	(15.3)	56.8	0.77	(0.65-0.91)	0.003‡

† Adequate consumption of fruits and vegetables: consumption equal to or greater than 400g per day (World Health Organization).

a Binge Drinking: episodic heavy drinking

b Beans and lentils (daily)

c Natural fruit juices, not included in the ortion of fruits and vegetables of the outcome under analysis (daily)

d Hot dogs and hamburgers (weekly)

OR, Odds Ratio. 95% CI, 95% confidence interval.

Univariate Logistic Regression.

‡ $p < 0.20$, variable included in the formation of the final hierarchical model.

Table 2: Univariate analysis model between associated behavioral factors and adequate consumption of fruits and vegetables, in baseline participants of the Cohort of Minas Gerais Universities - CUME Project, 2016, 2018.

Regarding individual factors, the median age was 34 (IQ: 12) years, with a minimum age of 20 years and a maximum of 86 years. Age was also categorized into age groups, in which the 30 to 39 age group was the one with the highest frequency of participants (42.4%, n=1,750). The elderly (≥ 60 years) age group also stood out with a frequency of 2.5% (n=103) of the participants. The female sex was

predominant, with 68.1% (n=2,808) women in the sample. Another individual factor evaluated was skin color, with 65.1% (n=2,683) having white skin color, 33.9% (n=1,400) black/brown, and 1% (n=41) yellow/indigenous. Of the participants who answered the self-reported health status, half (50%, n=2,061) marked "good". In relation to BMI, 56.4% (n=2,323) were classified as eutrophic, followed by 28.4% (n=1,171) and 11.7% (n=482) as overweight and obese, respectively. Regarding the presence of diseases, 41% (n=1,689) indicated the presence of SAH, 3.1% (n=128) the presence of DM, and 12.4% (n=513) the presence of depression.

In addition to the descriptive individual factors, "Table 3" demonstrates the associations of these variables with the outcome. It can be seen that from the variables in Block 3, only skin color, presence of SAH, and presence of depression were not associated with FV consumption in the univariate analysis.

BLOCK 3 – INDIVIDUAL FACTORS						
Variable	n	(%)	Adequate Consumption of FV (%) †	OR	(95% CI)	p-value
Sex						
Male	1316	(31.9)	59.3	1		
Female	2808	(68.1)	63.5	1.19	(1.04-1.36)	0.010‡
Age Classification						
20 – 29 years	1172	(28.4)	53.4	1		
30 - 39 years	1750	(42.4)	58.6	1.24	(1.06-1.43)	0.005‡
40 - 49 years	754	(18.3)	72.8	2.34	(1.92-2.84)	<0.001‡
50 - 59 years	345	(8.4)	80.9	3.69	(2.75-4.93)	<0.001‡
≥ 60 years	103	(2.5)	82.5	4.12	(2.44-6.94)	<0.001‡
Skin Color						
White	2683	(65.1)	61.9			
Brown/Black	1400	(33.9)	63.0	1	(0.92-1.20)	0.480
Yellow/Indigenous	41	(1.00)	56.1	0.79	(0.42-1.47)	0.451
Self-reported Health Status						
Very Good	1584	(38.5)	66.7	1		
Good	2061	(50.0)	60.0	0.74	(0.65-0.86)	<0.001‡
Fair	418	(10.2)	57.2	0.67	(0.53-0.83)	<0.001‡
Poor/Very Bad	55	(1.3)	54.5	0.60	(0.35-1.03)	0.063‡
Nutritional Status						
Eutrophy	2323	(56.4)	62.4	1		
Overweight	1171	(28.4)	63.2	1.03	(0.89-1.19)	0.637
Obesity	482	(11.7)	60.8	0.93	(0.76-1.14)	0.513
Low weight	146	(3.5)	54.4	0.75	(0.54-1.05)	0.097‡
Presence of SAH						
No	2435	(59.0)	61.4	1		
Yes	1689	(41.0)	63.4	1.09	(0.96-1.24)	0.203
Presence of DM						
No	3996	(96,9)	61.9	1		
Yes	128	(3.1)	72.7	1.64	(1.10-2.43)	0.014‡
Presence of Depression						
No	3611	(87.6)	62.3	1		
Yes	513	(12.4)	61.6	0.97	(0.80-1.17)	0.765

† Adequate consumption of fruits and vegetables: consumption equal to or greater than 400g per day (World Health Organization).

BMI, Body Mass Index. SAH, Systemic Arterial Hypertension. DM, Diabetes Mellitus.

OR, Odds Ratio. 95% CI, 95% confidence interval.

Univariate Logistic Regression.

‡ $p < 0.20$, variable included in the formation of the final hierarchical model.

Table 3: Univariate analysis model of individual factors associated with adequate consumption of fruits and vegetables, in baseline participants of the Cohort of Minas Gerais Universities - CUME Project, 2016, 2018.

"Table 4" presents the final hierarchical model of factors associated with adequate consumption of FV from the CUME Project baseline. With an explanatory power of 18%, and adequate final fit (p=0.32), it is also noteworthy that the final model was adjusted by the individual (continuous) income variable.

BLOCK 1 – SOCIOECONOMIC FACTORS				
Variable		OR	95% CI	p-value
No variables from this block remained in the final hierarchical model				
BLOCK 2 – BEHAVIORAL FACTORS				
Variable		OR	95% CI	p-value
Physical Activity				
Inactive		1		
Insufficiently active		1.36	(1.11-1.66)	0.003*
Active		2.10	(1.78-2.47)	<0.001*
Consumption of legumes [a]				
No		1		
Yes		1.21	(1.05-1.39)	0.007*
Consumption of natural juices [b]				
No		1		
Yes		2.00	(1.70-2.34)	<0.001*
Relative consumption (%) of ultra-processed foods		0.96	(0.95-0.97)	<0.001*
BLOCK 3 – INDIVIDUAL FACTORS				
Variable		OR	95% CI	p-value
Sex				
Male				
Female		1	(1.21-1.64)	<0.001*
Age Classification				
20 – 29 years		1		
30 - 39 years		1.14	(0.97-1.35)	0.107
40 - 49 years		2.13	(1.69-2.67)	<0.001*
50 - 59 years		3.07	(2.23-4.24)	<0.001*
≥ 60 years		3.41	(1.96-5.95)	<0.001*

Adequate consumption of fruits and vegetables: consumption equal to or greater than 400g per day (World Health Organization).

[a] Beans and lentils (daily)

[b] Natural fruit juices, not included in the portion of fruits and vegetables of the outcome under analysis (daily)

OR, Odds Ratio. 95% CI, 95% confidence interval.

Hierarchical Multivariate Logistic Regression.

Final model was adjusted by individual (continuous) income.

Hosmer and Lemeshow test = 0.32/ R Square Change = 0.18.

* $p < 0.05$.

Table 4: Hierarchical model of factors associated with adequate consumption of fruits and vegetables, in baseline participants of the Cohort of Minas Gerais Universities - CUME Project, 2016, 2018.

No Block 1 variable remained in the final hierarchical model. From Block 2, the physical activity variable remained, in which active individuals were approximately twice as likely to consume adequate FV (OR=2.10, 95%CI 1.78-2.47, p<0.001) compared to inactive individuals. As well, individuals with regular consumption of natural fruit juice also demonstrated twice the chance of adequate consumption of FV (OR=2.00, 95%CI 1.70-2.34, p<0.001), compared to those who did not present regular consumption of natural fruit juice. Regular consumption of legumes also showed a greater chance of adequate consumption of FV (OR=1.21, 95%CI 1.05-1.39, p=0.007). The consumption of ultra-processed foods was inversely associated with adequate consumption of FV (OR=0.96, 95%CI 0.95-0.97, p<0.001).

Of the individual factors, only sex and age classification remained in the final hierarchical model. Females were more likely to have adequate FV consumption (OR=1.41, 95%CI 1.21-1.64, p<0.001). Considering the age groups, it was observed that increasing age provided an increase in the chance of consuming an adequate amount of FV, highlighting the age group of the elderly, in which the chance of consuming adequate FV was approximately 3 times the chance of individuals 20 to 29 years of age (OR=3.41, 95%CI 1.96-5.95, p<0.001).

Discussions

Our study demonstrates that adequate consumption (≥ 400g/day) of FV was directly associated with the practice of physical activity, consumption of legumes, consumption of natural fruit juices, female gender, advancing age, and negatively with the consumption of ultra-processed foods.

The population of the present study showed a high frequency of individuals with adequate consumption of FV (62.2%), compared to other studies, such as Vigitel (22.9%) [30], Latin American Study of Nutrition and Health (7.2% in 8 Latin American countries) [31], and a study by Peltzer and Pengpid (2015) with students from 26 countries (17.2%) [32]. One of the reasons that may explain this result is the high education level of our cohort. In this regard, previous studies indicate that inadequate consumption of FV is associated with schooling and low income [9-10. 33-34].

In fact, education and income are related, and the average income of an individual with a higher education can reach more than three times the salary of an individual with only a complete elementary education, with even greater differences for individuals with a minimum level of education [35]. In addition, perceived barriers to FV consumption were investigated by Mackenbach et al., (2015) and related to different factors, highlighting the "Cost weighs on the family budget" associated with individuals with four years of schooling or less and a low-income level [36], and thus food costs are more strongly related to FV consumption for people with low socioeconomic status than for people with high socioeconomic status [34].

Another factor included in the composition of a person's socioeconomic position is professional status, since, although it can be independently associated with food consumption, it has an additional, synergistic effect when combined with income and education [37,38], and probably for this reason it also did not remain in the final model of the present study.

Regarding marital status, our study showed no association with the outcome, a result that is different from other studies, which showed a positive association with individuals who are married or in a stable union [9. 39-40], which may be related to the overload of functions of individuals without a partner, interfering with time to purchase, prepare, and consume FV [36].

Regarding behavioral factors, individuals who practice physical activity during leisure time tend to have a greater chance of having adequate consumption of FV, similar to another study with Brazilian workers in which physical activity while commuting was not significantly associated with food consumption outcomes, while leisure-time physical activity was associated with higher consumption of FV and lower consumption of snacks and sweets [41]. Corroborating these results, an association was also found between the practice of physical activity and adequate consumption of FV in a survey conducted with undergraduates from different countries [32] and with adults from the Center-West region of Brazil [9]. It is argued that physical activity and adequate consumption of fruit and vegetables constitute a healthy lifestyle, while a sedentary lifestyle and inadequate consumption of fruit and vegetables constitute risk behaviors and usually one tends to influence the presence of the other [42,43].

The consumption of so-called healthy and unhealthy foods is also related, since foods that constitute a healthy diet had a positive association with the outcome and unhealthy foods had a negative association, as in other investigations [9,10]. In the present study, a positive association was observed in relation to the consumption of natural fruit juices (not included in the amount of fruit in the outcome) and the consumption of legumes. The negative association remained with the consumption of ultra-processed foods.

Consumption of beans is related to lower values of body weight and waist circumference and reduced risk for obesity, given their nutritional value, especially the content of dietary fiber, potassium, zinc, iron, and lower amounts of fat and added sugars [44]. In our analysis, we extrapolated the regular consumption of beans to the consumption of legumes, because in our FFQ, we investigated the consumption of beans and lentils in the same option. Although the cultural value added to the consumption of beans, as a typical Brazilian food along with rice, cannot be evaluated in this study, in terms of nutritional issues, beans and lentils are similar [14], so it was decided to consider the regular consumption of legumes as exposure in this analysis, adding to the results that there is a greater chance of adequate consumption of FV in individuals who regularly consume legumes.

Another association observed is the regular consumption of natural fruit juices directly with the adequate consumption of FV. Natural fruit juices do not provide the same benefits as whole fruit, given that when prepared, the juices tend to lose fiber and some nutrients and its satiety power is lower. Even so, their consumption should be encouraged rather than ultra-processed juices, which are usually fruit-based drinks manufactured by industry with added sugars and/or artificial sweeteners [2]. Therefore, another positive association related to the regular consumption of healthy foods is demonstrated.

Regarding the consumption of unhealthy foods, the continuous variable of consumption of ultra-processed foods remained in the final model, which showed an inverse association with the outcome. In an analysis of the Brazilian population, fruit consumption was also inversely associated with the consumption of ultra-processed foods [45]. Ultra-processed foods have an unbalanced nutritional composition, often have an excess of sugars and/or fats in their content, in addition to sodium and additives to increase the palatability of these foods [2]. In addition, studies confirm that the higher consumption of these foods is directly associated with the presence of non-communicable diseases [46-48]. Therefore, the consumption of ultra-processed foods should be discouraged and the consumption of FV encouraged, guidance included in the golden rule of the DGBP, which is "always prefer fresh or minimally processed foods and culinary preparations over ultra-processed foods" [3].

Considering the variables in Block 3, only sex and age were associated with adequate consumption of FV in the final model. Females had a greater chance of adequate consumption of FV, and studies show that the prevalence of adequate consumption of FV is actually higher in women [6,9,40]. The Family Budget Research (POF 2017-2018) showed that men had a lower frequency of consumption of all FV evaluated, except potatoes [49]. The difference in FV consumption between the sexes can be attributed to women's greater concern with weight control and maintaining a healthy diet [50].

Age was strongly associated with the outcome, demonstrating that the chance of adequate consumption of FV increases with each age group, with the elderly having more than a 3 times greater chance of adequacy than an adult between 20 and 29 years of age. The association between age and adequate consumption of FV has occurred in other studies [6,9,40], the last POF stands out, in which the frequency of consumption estimated for age groups showed that the percentage of people who reported consumption of fruits and vegetables was higher in adults and elderly compared to adolescents, with the exception of acai and potatoes [49], in which case the method of preparation must be taken into account. A study with Latin American countries showed that fruit and vegetable consumption tends to increase with age, with older people consuming 50% more fruits and 23% more vegetables than younger people [31]. The direct association between increasing age and increased consumption of FV, possibly occurs due to the moment when the eating habits of older individuals were formed [9].

Adequate consumption of FV was not associated with the presence of diseases in this study, unlike what was found in other studies that showed a negative association with obesity [51], SAH [52], DM [53,54], and depression and psychological diseases [55], which suggests future analyses, especially longitudinal studies of this cohort, associating FV consumption with health outcomes and those related to the presence of diseases.

Thus, an important limitation of this study can be highlighted, namely its cross-sectional design, which does not allow establishing a causal relationship between exposure and outcome. In addition, some questions related to the environment, eating behavior, and food acquisition could add important findings if investigated.

However, the present study presented important results that corroborate the current literature, in which it is important to highlight the very specific characteristic of the sample, which is high education level and income, which allowed an important discussion around this issue. Also, knowing the particularities of this population helps in the promotion of more specific and efficient measures. Another point to be highlighted is the analysis carried out by logistic regression with hierarchical entry, which made it possible to contemplate the exposure factors at different levels, presenting relevant results. Finally, the validation of self-declared data in an online questionnaire is highlighted, which provides reliability of the results.

Conclusions

Adequate consumption (≥ 400g/day) of FV was directly associated with the practice of physical activity, consumption of legumes, consumption of natural fruit juices, female gender, age, and negatively associated with the consumption of ultra-processed foods in a population with a high level of education and high frequency of adequate consumption. Therefore, our findings reinforce the importance of health promotion as a whole and of personalized interventions for different sociodemographic groups.

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