

## Vending machines and university students' consumption trends

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### Summary

This work aimed at examination of consumption frequency, body weight, degree of satisfaction and food habits of vending machine users by interviewing 620 university students from the Gran Canaria Island, Spain, and Monte de Caparica, Portugal. A questionnaire was completed by participants, which gathered data on degree course and year, age, sex, weight, height and also the frequency of use of vending machines, the most consumed foods, level of satisfaction and new proposals for food to be provided by the machines. The most notable result was that the majority of the student population used food vending machines, and more than a half (50.8 %) used machines occasionally, i. e. once a week or less frequently. In general, the Spanish study population showed a higher prevalence for overweight (20.4 %) and obesity (3.2 %) compared with the Portuguese one (7.0 % for overweight and 0.8 % for obesity). It should also be noted that the daily use of vending machines was greater in Spain (13.4 %) than in Portugal (3.9 %). These findings could be used to improve dietary behaviour in university students in Spain and Portugal, if we take into account that many students consume or replace food with vending machine food daily or several times per week.

### Keywords

body weight; consumer; food habits; university student; vending machine

Recent decades have witnessed a significant increase in the development of industrial vending machines, while the rising prevalence of obesity among young people has elicited calls for schools, health authorities and researchers to be more active in promoting healthy weight. Being overweight and obese constitutes major public health issues in developed countries. On the Canary Islands (Spain), the overall obesity and overweight prevalence is 26.1 % among adolescents [1]. In the United Kingdom, approximately 58 % of women and 65 % of men are overweight or obese, where obesity prevalence has increased from 15 % in 1993 to 26 % in 2014 [2].

Commencing university studies can be a challenging period for undesirable weight gain, as it

was reported that university students may gain 1–3 kg during their first year of studies [3, 4] and this weight gain is likely to continue into adulthood [4]. University students' diets are usually high in fat, sugar and salt [5], which might contribute to the aforementioned weight gain [4, 6, 7], and also tend to continue in adulthood [3].

Therefore, the factors that influence food habits among university students need to be identified to prevent overweight and obesity problems later in life [8]. Several studies recently emphasised the potential role of vending machines in food habits and dietary quality. Food sold in vending machines in schools, hospitals and work settings was reported as low in fibre and high in energy, sugar and salt [9–11]. Vending machine

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accessibility and use were positively associated with eating snacks [12–14] and drinking soft drinks [15, 16]. However, a question remains how comprehensive, reliable and valid are current assessment tools for vending machines to support or refute these claims [17] and how can the profile of vending machine users be determined. These queries could help us to understand the behaviour of vending machine users, and to prevent overweight and obesity problems.

Spain is a European leader in vending machine use, with a consolidated industry and a highly integrated use. There are 560 000 vending machines across Spain, i.e. one machine for every 80 inhabitants. For comparison, Japan, the leader of this industry, has 5.5 million vending machines, which is one for every 23 people [18].

For decades, authors have voiced concern about the relatively low value of nutrients, and the high sugar and fat contents in many of the most frequently chosen food items [11, 19]. For this reason, and given the worldwide relevance of this problem, economists attempted to understand the main causes of obesity in the last decade by analysing factors such as food technological improvements, industrialization and the resulting mass food production, the drop in prices of energy-dense food, the increased availability of junk food and also the gradual shift towards an increasingly sedentary lifestyle [20]. Nowadays, such concern has led to some governments, as in Spain, to legislatively treat the products sold in vending machines in schools and colleges (Spanish Law 17/2011, especially Article 41) [21]. Similar situation is in Portugal, where the Ministry of Health recently published Order No. 7516-A/2016 on improving the food supply in vending machines available in various Ministry of Health institutions [22], which legally enforces the substitution of foods of less nutritional quality for other, “healthier” ones. Although the vending machine policy has been effective in changing snack behaviour in a wide variety of settings, only a few studies investigated snack vending behaviour in a university campus community [23, 24].

Despite the potential risks or health benefits, very little is known about the variety of food products and beverages sold in vending machines in university campuses. A study carried out by BYRD-BREDBENNER et al. [25], which attempted to assess the drinks and snacks sold in vending machines in different universities, reported that snacks and drinks had a poor nutritional quality. Most snacks were low in fibre and had high energy as well as fat contents, and almost half contained too much sugar. Most drinks also contained high

levels of sugar and energy. The findings of this study suggested that vending machines offered only a limited number of “healthy” options. Other studies demonstrated that the sale and consumption of “healthy” foods can be positively influenced by their increased availability [26]. Similarly, purchasing behaviour can be positively influenced by guiding customers to “healthier” choices through strategies, e.g. front-of-package labelling, or by providing information, reminders and reinforcement [27, 28]. As the effect of labelling itself is slight, it is likely to be more effective if combined with other methods [29, 30], e.g. strategies that influence purchasing behaviour by reducing the price of low-energy food [31]. The results of another study [32] indicated that when availability of low-energy foods increased and was combined with labelling that highlighted nutritional properties, and prices lowered at the same time, students made “healthier” choices without buying more or fewer products from vending machines.

Vending machines provide good availability of food and beverages in many environments, including schools [33], workplaces [34] and health centres [35]. In some places, availability of alternative healthy options of foods and beverages from vending machines may be limited [36]. Based on these data, providing a variety of “healthy” foods in such machines is extremely important to counteract the fact that most vending machines are typically stocked with food and beverages that are rich in energy but low in nutrients [24, 37].

For all these reasons, and given the Spanish Law 17/2011 on Food Safety and Nutrition [21] and Order No. 7516-A/2016 on improving food supplies in the vending machines available in various Ministry of Health institutions in Portugal [22], we believe that it is necessary to obtain new scientific data on the topic. In the present study, these would involve body weight and degree of satisfaction, in a multidimensional concept used as a holistic response variable, and the food habits of vending machine users from both the University of Las Palmas de Gran Canaria (Las Palmas, Gran Canaria, Canary Islands, Spain) and the Monte de Caparica University (Caparica, Portugal) populations. The reason for inclusion of the two countries is that the food habits of both countries are similar and are geographically linked, as well as Gran Canaria has a very strong Portuguese influence on its food culture due to the Portuguese participating in the conquest and later the colonization of the Canary Islands. Therefore, the present work aims to assess the differences in these factors according to body mass index (*BMI*) and country.

## MATERIALS AND METHODS

For this work, we comprehensively focused on the Gran Canaria Island (Spain) and placed particular emphasis on the University of Las Palmas de Gran Canaria (ULPGC; Las Palmas de Gran Canaria, Spain) university campuses. ULPGC has 25 172 students enrolled in various Degree programmes distributed over four campuses on Gran Canaria [38]. This research was also carried out at Egas Moniz University (EMU; Monte de Caparica, Portugal), a university campus with 2406 students. A self-administered survey was conducted among consumers of snacks and beverages from vending machines on both the Spanish and Portuguese university campuses, who voluntarily completed a questionnaire to assess vending machine behaviour, food habits and body weight. Written informed consent was obtained from all participants, and the protocol of this study was reviewed and approved by the Research and Ethics Committees of the ULPGC.

### Survey pre-testing

An independent survey with 40 individuals at each vending machine location (ULPGC and EMU university campuses) was conducted to provide a better notion of the sample. The data from the 40 individuals at ULPGC (31 females and 9 males, average age  $26.90 \pm 8.47$  years) suggested that assuming a campus sample was feasible, and also at EMU: (29 females and 11 males, average age  $27.55 \pm 7.69$  years). Before conducting the questionnaire, questions were pre-tested with five teachers of Nutrition and Food Safety from ULPGC, three teachers of Nutrition from EMU, eight ULPGC students and eight EMU students.

### Food habits, body weight and degree of satisfaction assessment

In order to relate the food habits in consuming food from vending machines, body weight and the degree of user satisfaction of the student populations at ULPGC and EMU, a specific questionnaire was developed.

The questionnaire was devised and based on the methodologies employed in various studies on food frequency [13, 39] and also on studies that considered the weight and height data provided by respondents [40–42]. The questionnaire consisted of three main parts.

The introductory part covered basic and necessary elements, including the questionnaire title, design goals and instructions on how to answer questions.

The second part aimed to collect personal in-

formation, such as gender, degree, age, grade, weight and height (neither was measured, but was reported by the participants), for comparison purposes.

The third part was closely related to food habits in consuming food from vending machines, food preferences and the degree of user satisfaction. In line with this objective, we selected different types of questions: two questions (frequency of using machines and frequency of using machines to replace a main meal, lunch or dinner) with four answer options: “Yes, everyday”, “Yes, several times a week”, “Yes, once a week, or less frequently”, “No, never”.

Another question was to indicate which food items users consumed preferably among all those available in machines. Among all the foods available in machines (water, soft drinks, juices/smoothies, pastries, diet drinks, salty products, chocolate bars, coffee/tea), the participants should score each one according to their preferred consumption, based on a 6-point Likert scale (0 – completely disagree, 1 – disagree, 2 – somewhat disagree, 3 – somewhat agree, 4 – agree, 5 – completely agree). This means that the higher the score given to each food, the greater its consumption. For example, if an individual scored soft drinks at zero, it meant that he or she never consumed soft drinks from the machines; however, if he or she scored 5, it meant that he or she consumed or preferred soft drinks from vending machines.

Another question on the products offered in machines comprised three items, namely, variety, quality and nutritional value, to be answered on a 6-point Likert scale. Defining the term “quality” is a complex matter, a concept that depends largely on the individual [43], and it is very unlikely that two individuals coincide in its definition [44]. Despite this difficulty, it was considered important to know up to what point the food available in vending machines can be considered a quality food from consumers' points of view. Therefore, this issue was also included in the specifically designed questionnaire.

Regarding “satisfaction”, it is important to mention that customer's (dis)satisfaction is in accordance with the disconfirmation that results from contradiction between prior expectations and actual performance [45], which can be defined as the customer's fulfilment response [46]. The term “variety” corresponds to the range of food items offered in vending machines, including hot, healthier and special diet options, according to the necessities and habits of vending machine users. Food variety should be emphasized so as to not

create student dissatisfaction by monotonous food [47].

Finally, the nutritional value of food refers to the quantity and quality of nutrients found in the food item according to United States Department of Agriculture (USDA) Food Composition Databases [48]. Information about the energy (measured in joules), macronutrients (carbohydrates, protein, fats), micronutrients (vitamins and minerals) and phytochemicals of food are required to understand this.

There is also an open question about the foods that consumers would like to become available in machines. The final question is about the degree of satisfaction, measured by a 10-point hedonic scale (1 – very poor, 2/3 – poor, 3/4 – fair, 5/6 – good, 7/8 – very good, 9/10 – excellent) to determine views on current and potential opportunities to change aspects of the food environment in the future [47].

During an 8-month period, the questionnaire was given to 492 students in different ULPGC centres, and the same questionnaire was also given during 3 months to 128 EMU students. The questionnaire was immediately collected by two trained researchers (postgraduate veterinary students) once it was completed. Interviews were conducted in entrance areas of various faculties. Participants were informed of the study aims and were provided with an information sheet. All the data were collected on an individual basis, with the investigator discreetly present to resolve any queries. All the participants were volunteers as no incentive of any kind was offered, and the questionnaire was anonymous.

### Statistical analysis

The data analysis of this work was carried out with the statistical software package SPSS 20.0 (SPSS, Chicago, Illinois, USA) for MAC OS X

(Apple Computers, Cupertino, California, USA). For the total vending machine users and each gender group, categorical variables were summarized in frequencies, and percentages and numerical variables in means and standard deviations or medians ( $P_{50}$ ) and interquartile ranges ( $IQR$ ,  $P_{25}$ – $P_{75}$ ), according to assumptions of normality. Percentages were compared as appropriate with the chi-square test or Fisher's exact test, means with the  $t$ -test and medians with the Wilcoxon test for independent data. A hypothesis test was considered statistically significant if the corresponding  $p$ -value was lower than 0.05.

## RESULTS AND DISCUSSION

Six hundred and twenty students consented to participate in the study. Tab. 1 presents the results on the total number of surveyed students (Spain and Portugal) per gender. These results showed that male respondents had a higher  $BMI$  ( $24.4 \pm 3.1 \text{ kg}\cdot\text{m}^{-2}$ ) than females ( $22.2 \pm 3.2 \text{ kg}\cdot\text{m}^{-2}$ ). All the underweight individuals were female ( $n = 8$ ) with a high statistical significance ( $p < 0.001$ ). It should be noted that according to World Health Organization (WHO) criteria [49], the mean  $BMI$  values detected for both genders corresponded to those of normal weight ( $18.5 \text{ kg}\cdot\text{m}^{-2} \leq BMI < 25 \text{ kg}\cdot\text{m}^{-2}$ ) individuals ( $23.2 \pm 3.3 \text{ kg}\cdot\text{m}^{-2}$ ), and only 20.3% were overweight ( $25 \text{ kg}\cdot\text{m}^{-2} \leq BMI < 30 \text{ kg}\cdot\text{m}^{-2}$ ) and 3.4% were obese ( $BMI \geq 30 \text{ kg}\cdot\text{m}^{-2}$ ).

It is noteworthy that 55.5% of students were enrolled in Degree programmes in Health Sciences or Physical Education and Sport, and significantly more women (70.7%;  $n = 234$ ) than men (38.1%;  $n = 110$ ) studied these degrees ( $p < 0.001$ ). Therefore, most of the study population had a background that allowed them

Tab. 1. Personal data from participants according to gender.

	Total ( <i>n</i> = 620)		Men ( <i>n</i> = 289)		Women ( <i>n</i> = 331)		<i>p</i>
Age (years)	22.4 ± 3.5		22.5 ± 3.9		22.3 ± 3.2		0.596
<i>BMI</i> [kg·m <sup>-2</sup> ]	23.2 ± 3.3		24.4 ± 3.1		22.2 ± 3.2		< 0.001
<b>Weight status</b>							
	Number	[%]	Number	[%]	Number	[%]	
Underweight ( <i>BMI</i> < 18.5 kg·m <sup>-2</sup> )	18	2.9	0	0	18	5.4	< 0.001
Normal weight (18.5 kg·m <sup>-2</sup> < <i>BMI</i> < 25 kg·m <sup>-2</sup> )	473	76.3	196	67.8	259	78.2	< 0.001
Overweight (25 kg·m <sup>-2</sup> ≤ <i>BMI</i> < 30 kg·m <sup>-2</sup> )	126	20.3	79	27.3	47	14.2	< 0.001
Obese ( <i>BMI</i> ≥ 30 kg·m <sup>-2</sup> )	21	3.4	14	4.8	7	2.1	< 0.001

Data are expressed as means  $\pm$  standard deviation for age and body mass index.

$p$  –  $p$ -value applies to the significance of the difference in response between genders,  $BMI$  – body mass index.

**Tab. 2.** Behaviour and options on use of vending machines according to gender.

	Total (n = 620)		Men (n = 289)		Women (n = 331)		p
Frequency of vending machine use							
	Number	[%]	Number	[%]	Number	[%]	
Daily	65	10.5	34	11.8	31	9.4	0.615
Several times a week	140	22.6	62	21.5	78	23.6	0.615
Once a week, or less frequently	315	50.8	143	49.5	172	52.0	0.615
Never	100	16.1	50	17.3	50	15.1	0.615
Frequency of meal replacement							
	Number	[%]	Number	[%]	Number	[%]	
Daily	23	4.4	19	7.9	4	1.4	< 0.001
Several times a week	49	9.4	22	9.1	27	9.6	< 0.001
Once a week, or less frequently	134	25.7	78	32.4	56	19.9	< 0.001
Never	316	60.5	122	50.6	194	69.0	< 0.001
Food available in machines							
	Median	IQR	Median	IQR	Median	IQR	
Water	2	1–4	2	1–4	2	1–4	0.788
Soft drinks, median	2	1–3	2	1–3	2	0–3	< 0.001
Juices/smoothies	1	0–3	2	0–3	1	0–3	0.006
Pastries	2	1–3	2	1–3	2	1–4	0.705
Sandwiches	1	0–3	1	1–3	1	0–3	0.145
Diet drinks	1	0–3	1	0–3	1	0–2	0.088
Salty products	2	0–4	2	1–3	1	0–4	0.062
Chocolate bars	2	1–3	2	1–4	1	0–4	0.976
Coffee/tea	2	1–3	2	1–3	2	1–3	0.329
Personal opinion about food vending machines							
	Median	IQR	Median	IQR	Median	IQR	
Variety	3	2–4	3	2–4	3	2–4	0.296
Quality	3	2–4	3	2–4	3	2–3	0.012
Nutritional value	2	1–3	2	1–3	2	1–3	0.786
Degree of satisfaction	6	5–8	7	5–8	6	5–7	< 0.001
Food wished to be seen available in machines							
	Number	[%]	Number	[%]	Number	[%]	
Salads	55	8.9	30	10.4	25	7.6	0.217
Burgers	52	8.4	32	11.1	20	6.0	0.024
Ice-creams	41	6.6	29	10.0	12	3.6	0.001
Nuts	59	9.5	33	11.4	26	7.9	0.131
Fruit	261	42.1	107	37.0	154	46.5	0.017
Cookies	43	6.9	16	5.5	27	8.2	0.200
Cereals	41	6.6	22	7.6	19	5.7	0.349
Confectionery	37	6.0	21	7.3	16	4.8	0.202
Yogurt	69	11.1	28	9.7	41	12.4	0.287

Median and interquartile range values are expressed as Likert scale score.

*IQR* – interquartile ranges, *p* – *p*-value applies to the significance of the difference in response between genders.

to acquire knowledge about health and to lead “healthy” life styles, which includes an adequate diet and each individual’s needs, along with doing physical exercise. Likewise, CAVALIERE et al. [50] confirmed the hypothesis that consumers with a high orientation to the future tend towards a “healthy” weight whereas consumers who are

more concerned about the present are more likely to exhibit excess weight. In other words, when consumers generally consider future consequences on health in their dietary habits, their *BMI* levels become lower.

With regard to food habits, see Tab. 2, it was verified that the majority of the student population



used food vending machines, as only 16.1% admitted never purchasing products from machines, and more than a half (50.8%) used machines once a week/twice a month/monthly. Notably, 60.5% reported never replacing a main meal (lunch or dinner) with food purchased through vending machines and only 4.4% did so daily. It is also worth noting that 33.1% of the subjects, almost one third, and both males and females, used vending machines daily or several times per week.

Regarding the general choice of foods from machines, the main difference verified between genders was juices/smoothies, which were more commonly purchased by males ( $P_{50} = 2$ ) compared to the females' purchasing behaviour ( $P_{50} = 1$ ), these results being statistically sig-

nificant ( $p = 0.006$ ). It is worth mentioning that among the foods that respondents wished to see available in vending machines, fruit was the most requested (42.1% of the individuals who completed the questionnaire wanted this food), with women requesting it more ( $n = 154$ ) compared with men ( $n = 107$ ), this difference being statistically significant ( $p = 0.017$ ). This may serve as a good stimulus for vending companies to introduce other food types into machines with a better nutritional profile, e.g., in accordance with WHO recommendations [51], and with the reference daily values set by the Food and Drug Administration (FDA) [52]. Following this, a recent study by RAPOSO et al. [24] concluded that vending machine foods contain more fat/saturated fat, energy

**Tab. 3.** Behaviour and opinions on use of vending machines according to body mass index.

	Normal weight ( <i>n</i> = 473)		Overweight ( <i>n</i> = 126)		Obese ( <i>n</i> = 21)		<i>p</i>
Age (years)	22.0 ± 3 <sup>a</sup>		23.6 ± 4.6 <sup>b</sup>		24.4 ± 4 <sup>b</sup>		< 0.001
Frequency of vending machine use							
	Number	[%]	Number	[%]	Number	[%]	
Daily	47 <sup>a</sup>	9.9 <sup>a</sup>	13 <sup>a</sup>	10.3 <sup>a</sup>	5 <sup>b</sup>	23.8 <sup>b</sup>	0.045
Several times a week	101 <sup>a</sup>	21.4 <sup>a</sup>	30 <sup>a</sup>	23.8 <sup>a</sup>	9 <sup>b</sup>	42.9 <sup>b</sup>	0.045
Once a week, or less frequently	246 <sup>a</sup>	52.0 <sup>a</sup>	62 <sup>a</sup>	49.2 <sup>a</sup>	7 <sup>b</sup>	33.3 <sup>b</sup>	0.045
Never	79 <sup>a</sup>	16.7 <sup>a</sup>	21 <sup>a</sup>	16.7 <sup>a</sup>	0 <sup>b</sup>	0 <sup>b</sup>	0.045
Frequency of meal replacement							
	Number	[%]	Number	[%]	Number	[%]	
Daily	14 <sup>a</sup>	3.5 <sup>a</sup>	6 <sup>a</sup>	5.7 <sup>a</sup>	3 <sup>b</sup>	14.3 <sup>b</sup>	0.036
Several times a week	35 <sup>a</sup>	8.8 <sup>a</sup>	11 <sup>a</sup>	10.5 <sup>a</sup>	3 <sup>b</sup>	14.3 <sup>b</sup>	0.036
Once a week, or less frequently	97 <sup>a</sup>	24.5 <sup>a</sup>	35 <sup>a</sup>	33.3 <sup>a</sup>	2 <sup>b</sup>	9.5 <sup>b</sup>	0.036
Never	250 <sup>a</sup>	63.1 <sup>a</sup>	53 <sup>a</sup>	50.5 <sup>a</sup>	13 <sup>b</sup>	61.9 <sup>b</sup>	0.036
Personal opinion about food vending machines							
	Median	<i>IQR</i>	Median	<i>IQR</i>	Median	<i>IQR</i>	
Variety	3	2–4	3	2–4	3	2–4	0.534
Quality	3	2–4	3	2–3	3	2–4	0.536
Nutritional value	2	1–3	2	1–3	3	1–3	0.528
Degree of satisfaction	6 <sup>a</sup>	5–7 <sup>a</sup>	2 <sup>b</sup>	1–3 <sup>b</sup>	3 <sup>b</sup>	1–3 <sup>b</sup>	0.007
Food wished to be seen available in machines							
	Number	[%]	Number	[%]	Number	[%]	
Salads	34 <sup>a</sup>	7.2 <sup>a</sup>	19 <sup>b</sup>	15.1 <sup>b</sup>	2 <sup>ab</sup>	9.5 <sup>ab</sup>	0.022
Burgers	38	8	11	8.7	3	14.3	0.592
Ice-cream	26	5.5	13	10.3	2	9.5	0.133
Nuts	37 <sup>a</sup>	7.8 <sup>a</sup>	20 <sup>b</sup>	15.9 <sup>b</sup>	2 <sup>ab</sup>	9.5 <sup>ab</sup>	0.024
Fruit	204	43.1	52	41.3	5	23.8	0.210
Cookies	36	7.6	4	3.2	3	14.3	0.088
Cereals	34	7.2	5	4.0	2	9.5	0.374
Confectionery	29	6.1	6	4.8	2	9.5	0.663
Yogurt	56	11.8	10	7.9	3	14.3	0.417

Data are expressed as mean  $\pm$  standard deviation for age. Median and interquartile range values are expressed as Likert scale score. Different letters in superscripts indicate a statistically significant difference between body mass index groups.

The negligible underweight category was omitted.  $p$  –  $p$ -value applies to the significance of the difference in response between normal weight, overweight and obese individuals, IQR – interquartile ranges.

and sodium than recommended, pointing out the importance of government's awareness and policies that promote the intake of "healthy" foods are essential to increase the amount of foods with an appropriate nutrition profile, according to recommendations, in vending machines.

In relation to the degree of satisfaction with the services offered by the vending industry, men valued this item more ( $P50 = 7$ ) than women ( $P50 = 6$ ).

Tab. 3 shows the data on *BMI* of respondents, where the underweight category was considered irrelevant due to the low prevalence of the individuals included in this category ( $n = 18$ ) compared to normal weight ( $n = 473$ ) and excess weight ( $n = 147$ ) ones. The first thing to note was the fact that average age was greater in overweight individuals ( $23.6 \pm 4.6$  years), and even higher in obese ones ( $24.4 \pm 4$  years), than normal weight individuals ( $22.0 \pm 3$  years) ( $p < 0.001$ ). Another noteworthy fact was that 42.9% of obese individuals resorted to vending machines several times a week, which was a significantly higher percentage than for normal weight (21.4%) and overweight (23.8%) individuals ( $p = 0.045$ ). It was also noteworthy that 66.7% of obese users of vending machines were frequent users (daily or several times a week), and this difference was statistically significant ( $p = 0.045$ ) compared with overweight frequent users (34.1%) and normal weight frequent users (31.3%).

In relation to replacing the main meal (either lunch or dinner) with food from a vending machine, remarkably more than a half the obese subjects (61.9%), overweight subjects (50.5%), and normal weight subjects (63.1%) mentioned that they never did this. Here a statistically significant difference ( $p = 0.036$ ) was found between normal weight and overweight individuals compared with obese individuals. It is also noteworthy that 28.6% of obese subjects replaced a main meal with food from vending machines daily or several times per week, and this difference was statistically significant ( $p = 0.036$ ) compared with overweight (16.2%) and normal weight users (12.3%), where this value decreased.

Among the food items that university students wished to be more available in vending machines, fruit was highlighted by normal weight (43.1%), overweight (41.3%) and obese (23.8%) individuals. The degree of satisfaction with the services offered by the vending industry of normal weight individuals was much higher ( $P50 = 6$ ) than of obese ( $P50 = 3$ ) and overweight subjects ( $P50 = 2$ ). A significant difference was found in the answers given by normal weight individuals

compared with the others ( $p = 0.007$ ).

Tab. 4 shows the results of the respondents who studied Degrees in Health Sciences per country. These results showed that respondents in Spain had a significantly higher *BMI* ( $23 \pm 3.3 \text{ kg}\cdot\text{m}^{-2}$ ) compared with those in Portugal ( $21.6 \pm 2.6 \text{ kg}\cdot\text{m}^{-2}$ ) ( $p < 0.001$ ). However, it should be noted that according to the WHO [49], the mean *BMI* values found for both countries corresponded to normal weight individuals, but a significantly higher prevalence of overweight (20.4%) and obesity (3.2%) was observed in Spain than in Portugal ( $p = 0.001$ ).

The data revealed that in Spain, the vast majority of students (60.2%) used vending machines once a week, or less frequently and, although this was the same frequency as in Portugal, the percentage was somewhat lower (46.9%), with significant differences found between the obtained results ( $p < 0.001$ ). In Portugal, there were many more frequent users, daily or several times a week (40.6%), than in Spain (22.7%) ( $p < 0.001$ ), where rare users (once a week or less) prevailed (77.3%) compared with Portugal (59.4%) ( $p < 0.001$ ).

Most health science students in both countries (83.0% in Portugal and 59.2% in Spain) responded that they never replaced a main meal with the food available in vending machines, these differences being significant ( $p < 0.001$ ). In general, there were many more daily Spanish vending machine users (13.4%) than Portuguese (3.9%) ( $p < 0.001$ ). There was also a progressive trend towards obese subjects (3.2%) in Spain compared with Portugal (0.8%) ( $p = 0.001$ ).

Regarding the food consumed, the fact that more soft drinks are consumed in Spain ( $P50 = 2$ ) than in Portugal ( $P50 = 0$ ) should be noted, along with the high statistical significance in hypothesis testing ( $p < 0.001$ ). Salty products were also consumed much more in Spain ( $P50 = 2$ ) than in Portugal ( $P50 = 0$ ), with a high statistical significance between the obtained results ( $p = 0.006$ ). According to the report published by WHO and entitled "Fiscal Policies for Diet and Prevention of Non-Communicable Diseases (NCDs)" [53], increasing the retail price of soft drinks by at least 20% could result in a significant reductions in their consumption. In accord with this, the Spanish Government will implement in 2017 a new tax on soft drinks, including all soft drinks [54].

Among the foods that respondents in both countries wished to see available in machines, fruit was the most popular, which 47.7% of the Portuguese and 44.4% of the Spanish respondents suggested. It was also noteworthy that 12% of Spanish students wanted burgers to become avail-

**Tab. 4.** Behaviour and opinions on use of vending machines according to country.

	Portugal ( <i>n</i> = 128)		Spain ( <i>n</i> = 216)		<i>p</i>
Age (year)	22.3 ± 3.7		22.6 ± 2.8		0.324
<i>BMI</i> [kg·m <sup>-2</sup> ]	21.6 ± 2.6		23 ± 3.3		< 0.001
<b>Weight status</b>					
	Number	[%]	Number	[%]	
Underweight ( <i>BMI</i> < 18.5 kg·m <sup>-2</sup> )	118	92.2	165	76.4	0.001
Normal weight (18.5 kg·m <sup>-2</sup> < <i>BMI</i> < 25 kg·m <sup>-2</sup> )	9	7.0	44	20.4	0.001
Overweight (25 kg·m <sup>-2</sup> ≤ <i>BMI</i> < 30 kg·m <sup>-2</sup> )	1	0.8	7	3.2	0.001
<b>Frequency of use of the machines</b>					
	Number	[%]	Number	[%]	
Daily	5	3.9	29	13.4	< 0.001
Several times a week	47	36.7	20	9.3	< 0.001
Once a week, or less frequently	60	46.9	130	60.2	< 0.001
Never	16	12.5	37	17.1	< 0.001
<b>Frequency of meal replacement</b>					
	Number	[%]	Number	[%]	
Daily	0	0	12	6.7	< 0.001
Several times a week	4	3.6	18	10.1	< 0.001
Once a week, or less frequently	15	13.4	43	24.0	< 0.001
Never	93	83.0	106	59.2	< 0.001
<b>Food available in machines</b>					
	Median	IQR	Median	IQR	
Water	1	1–2	3	1–5	0.001
Soft drinks	0	0–4	2	1–3	< 0.001
Juices/smoothies	0	0–4	1	0–3	0.020
Pastries	3	0–4.5	2	1–3	0.126
Sandwiches	0	0–4	1	1–3	0.005
Diet drinks	0	0–5	1	0–2.5	0.006
Salty products	0	0–5	2	1–3	0.006
Chocolate bars	2	0.5–4	2	0.5–3	0.544
Coffee/tea	2	1–3	2	1– 3	0.949
<b>Personal opinion about food vending machines</b>					
	Median	IQR	Median	IQR	0.324
Variety	3	3–4	3	2–3	0.002
Quality	3	2–3	3	2–3	0.685
Nutritional value	2	1–3	2	1–3	0.278
Satisfaction degree	6	5–7	6	5–7	0.413
<b>Food wished to be seen available in machines</b>					
	Number	[%]	Number	[%]	
Salads	9	7.0	18	8.3	0.664
Burgers	0	0	26	12.0	< 0.001
Ice-creams	2	1.6	14	6.5	0.036
Nuts	4	3.1	25	11.6	0.006
Fruit	61	47.7	96	44.4	0.563
Cookies	9	7.0	16	7.4	0.897
Cereals	11	8.6	8	3.7	0.055
Confectionery	6	4.7	9	4.2	0.819
Yoqurt	17	13.3	29	13.4	0.970

Data are expressed as mean ± standard deviation for age and body mass index. Median and interquartile range values are expressed as Likert scale score.

*p* – *p*-value applies to the significance of the difference in response between countries. *BMI* – body mass index, *IQR* – interquartile ranges.



able, but no respondents in Portugal mentioned this option. This difference was also highly significant ( $p < 0.001$ ).

Students from both countries reported being satisfied with the services offered by food vending machines (degree of satisfaction:  $P50 = 6$ ).

It is important to note that the studied university populations in Portugal and Spain were considered to exhibit normal weight according to the WHO's benchmarks [49] given the average *BMI* score of  $23.2 \pm 3.3 \text{ kg}\cdot\text{m}^{-2}$ . These data contrast with the findings of other studies [55–57], who reported that young adults live more independent and self-sufficient life styles than those within the age range for increased risk of obesity and “unhealthy” weight gain.

On food habits, the research by KUBIK et al. [19] inversely related consumption of fruit to number of vending machines. However, the results of the present study showed that more students requested this food type in vending machines. The findings of GODIN et al. [16] showed that items which young people purchase from school vending machines were directly associated with sugar-sweetened beverage purchases and intake and, moreover, sugar-sweetened beverages were purchased by more students than any other item (water). Those results are contrast with the consumer trends observed herein, as in Portugal, 50 % of the respondents reported not consuming such foods and only low consumption was reported in Spain ( $P50 = 2$ ), as shown in Tab. 4.

In the study conducted by FREEDMAN and RUBINSTEIN [58], in the primary and secondary school environment, 19 % of a staff sample in faculties ( $n = 806$ ) at a large urban university indicated that they purchased snacks from vending machines. Although vending machines are more often used for snacking, in a study of 1918 adults who worked away from home, 84 (4.4 %) indicated vending machines as their primary site for purchasing lunch items during work hours [59]. For individuals who work long hours, vending machines may be the only available source of food at their worksite, which thus demonstrates the importance of the availability of “healthy” products in vending machines [60]. Similarly in a university campus environment, accessibility to dining options may be limited due to small food-providing facility locations and their opening hours, and can render vending machines the sole source of foods and beverages readily available to individuals in this environment [25, 34]. As vending machines are becoming increasingly more prevalent and available, and thus supply a growing proportion of individuals' daily energy intake, and as dietary and

food habits are strongly influenced by food availability and accessibility, it is important to accurately assess and monitor various aspects of the food and nutrition environment, including vending machines. In this way, the results of the present study contribute to re-inforce the importance of introducing a wider range of food items with a better nutritional profile in vending machines to promote a “healthier” environment among users.

## CONCLUSIONS

Most of the studied population was of normal weight (average *BMI* =  $23.2 \pm 3.3 \text{ kg}\cdot\text{m}^{-2}$ ) and more than half (50.8 %) stated that they ate food from vending machines once per week, or less frequently, and this frequency increased in obese and overweight consumers. We emphasize that 55.5 % of the participants were studying Degrees in Health Sciences/Physical Education and Sport, so they should have more knowledge on nutrition and lack of “healthy” options in vending machines. Generally, it is important to highlight that 66.7 % of obese users of vending machines were frequent users (daily or several times a week). In Portugal, we found many more frequent users (40.6 %) than in Spain (22.7 %). Regarding weight status, we stress that 28.6 % of obese subjects replaced daily or several times per week a main meal with food from vending machines, and this value gradually lowered for overweight (16.2 %) and normal weight users (12.3 %). Portuguese and Spanish individuals rated the vending industry positively ( $P50 = 6$ ). Fruit was the food that respondents suggested to be made available in vending machines, 42.1 % of the respondents requesting this food type. This study was carried out in two different universities in Spain and Portugal and is not representative of all university students in these countries, but can be indicative of current consumption habits of “healthy” foods and food habits regarding vending machines. For this reason, the findings from the present paper can be used to stimulate the development of environmental interventions that focus on vending machines to improve “healthy” food habits in university students. We urge researchers worldwide to consider and to conduct similar studies in their respective countries. Availability of “healthy” foods and beverages in vending machines, as well as food policies that foster “healthful” food choices among students need to be paid more attention. Scientific studies should support policies with the potential benefit to public health, despite the fact that their implementation may be politically difficult.

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