Environmental footprints and eco-efficiency of food used in a hospital in Uruguay

Pegadas ambientais e ecoeficiência dos alimentos utilizados em um hospital do Uruguai

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ABSTRACT

The foods used to provide meals for communities cause different environmental impacts. This article aimed to identify the environmental impacts of environmental footprints and greenhouse gases (GHG) and calculate eco-efficiency (EE) according to the foods used by a food service at the Hospital de Clínicas (HC) in Montevideo. The foods purchased by the HC in 2021 and the first half of 2022 were evaluated. Of the list of 90 foods, 38 of them were responsible for more than 95% of the amount used. In the evaluation of the variables, eight foods of animal origin represented 33.3% of the total in kg and 52.3% of the economic value, and from 74% to 89.7% in terms of the footprints evaluated. The amount used and the place of origin of some foods directly influenced the GHG results found.

Keywords: Hospital food. Greenhouse gases. Environmental footprints. Nutrition.

RESUMO

Os alimentos utilizados no fornecimento de refeições para coletividades provocam diferentes impactos ambientais. Esse artigo teve como objetivo identificar os impactos das pegadas ambientais e dos gases de efeito estufa (GEE) e calcular a ecoeficiência (EE) segundo os alimentos utilizados por um serviço de alimentação do Hospital de Clínicas (HC) em Montevidéu. Foram avaliados os alimentos comprados pelo HC em 2021 e no primeiro semestre de 2022. Da lista de 90 alimentos, 38 foram responsáveis por mais de 95% da quantidade utilizada. Na avaliação das variáveis, oito alimentos de origem animal representaram 33,3% do total em kg e 52,3% do valor econômico, e de 74% a 89,7% em relação às pegadas avaliadas. A quantidade utilizada e o lugar de origem de alguns alimentos influenciaram diretamente nos resultados encontrados de GEE

Palavras-chave: *Alimentação Hospitalar. Gases de efeito estufa. Pegadas ambientais. Nutrição.*

1 INTRODUCTION

Access to food is an essential right for survival and must be guaranteed to all people, according to the Universal Declaration of Human Rights of the United Nations (ONU, 1948). To guarantee and make available the most diverse types of food to the population, the process of marketing products is carried out, which plays an important role in global food security and resource sustainability (MacDonald *et al*., 2015).

The globalisation of the food market has made a change in the geography of food systems. In turn, agricultural trade ends up changing the distribution of land and water use between regions (Porkka *et al*., 2013). It is estimated that about one-fifth of the world's agricultural land and water use is dedicated to producing agricultural products consumed by other countries (Hoekstra; Mekonnen, 2012; Kastner *et al*., 2014). For food production, agriculture and livestock are estimated to be responsible for using about 70% of the world's total freshwater and 26% of global greenhouse gases (GHG) emissions (Ritchie; Roser, 2020).

The production and distribution of food will supply consumers for domestic use, and providers of community food services at commercial and institutional levels. The provision of meals to a community is usually carried out in spaces called Food and Nutrition Unit (FNU) (UAN in Portuguese). An FNU is an establishment that prepares and distributes meals to communities in the most diverse modalities, including hospital services (Abreu; Spinelli, 2016).

Hospital food is distributed by sectors called Nutrition and Dietetics Services (NDS). The offer of food for hospitalised patients can include different services, considering the main options such as breakfast, lunch, snack, dinner, and, eventually, suppers.

The responsibilities of an NDS are preparing and providing nutrient-balanced meals according to the patient's profile (Oliveira *et al*., 2017). Food planning must be done for this profile while considering several factors, such as pathology, clinical condition, age, and sex, among many others, respecting individual particularities (Araújo; Macedo, 2020). Providing meals in a hospital context is an important function for the recovery and maintenance of patients' nutritional and health status (Simzari *et al*., 2017).

Consuming nutritious food requires a comprehensive view of sustainable food production and intake. The definition of the sustainability concept is related to strategies that seek to improve society's quality of life in the long term, as well as the maintenance of environmental resources in quantity and quality (Feil; Schreiber, 2017).

Due to the large number of meals prepared, FNU plays a crucial role in ensuring healthy and sustainable food. Thus, it is considered relevant to effectively analyse the quality of the food purchased, as well as the origin of raw materials, to consider the aspects of sustainable nutrition (Strasburg *et al*., 2021). In addition to environmental, economic, and social aspects (triple bottom line), the concept of sustainable nutrition includes the pillars of health and culture (von Koerber *et al*., 2017).

Many items are identified in the preparation of meals for the community, such as physical facilities, equipment, people, and, above all, the acquisition of raw materials (food) and, consequently, the generation of waste (Busato; Ferigollo, 2018; Harmon; Gerald, 2017; Mota *et al*., 2017; Strasburg; Jahno, 2017a). We also have other environmental impacts related to the production of food and meals, which can be measured through indicators such as environmental footprints. These footprints are described, and the following footprints are used in research on the subject: water (WF), carbon (CF), and ecological (EF). Each of these footprints has a distinct definition and particularities regarding its measurement.

Hoekstra and Huang created the Water Footprint (WF) concept in 2002 to assess humanity's water consumption (Yu *et al*., 2010). WF is used as an indicator to quantify the use of freshwater (in litres) directly and indirectly during the production process of a given good (Hoekstra *et al*., 2009).

First, to understand the Carbon Footprint (CF), it is necessary to address the emission of greenhouse gases. According to the Kyoto Protocol, six GHGs are used (Carbon Trust, 2022) to verify emissions, which are accounted for in the form of carbon dioxide equivalents (CO2e) (Caiado *et al*., 2017). Therefore, CF is an estimate of the total amount of GHG emitted from the perspective of a product's life cycle and its contribution to climate change (Röös, 2013).

In turn, the Ecological Footprint (EF) is a tool that was created to assess the impact of human activity on the environment. More precisely, EF seeks to measure the biologically productive area of land and water required to produce all resources and absorb the waste of an individual, population, or activity (Hatjiathanassiadou *et al*., 2023). For the analysis of the EF, the lands are considered according to the following purposes: a) crops, b) grazing products, c) forest products, d) seafood, e) built land, and f) carbon footprint (Wackernagel *et al*., 2019).

Another way to measure environmental impacts is through Eco-Efficiency (EE). EE is a tool that allows for assessing the relationship between aspects (value) of products or services concerning the environmental impacts of a process (Carvalho *et al*., 2017). The concept of EE was defined by the World Business Council for Sustainable Development and it advocates for the most efficient use of materials and energy, combining economic and environmental performance to reduce environmental impacts, using raw materials and energy more rationally and improving the relationship between organisations and stakeholders (WBCSD, 2000).

Uruguay is a South American country located in the extreme south of the continent and has a strong primary production characteristic (Alberto, 2019). The Uruguayan population is estimated at about 3.5 million people, of which nearly 50% live in Montevideo, the country's capital (Dados Mundias, 2022; INE, 2011). In this capital is the *Hospital de Clínicas* (HC), which serves the adult population in general and is a reference in highly complex procedures. The HC serves people, regardless of their social status, through Uruguay's national health system (HCMQ, 2022).

Considering that nutritional and health aspects are considered in the hospital environment when providing meals, this study broadens these horizons and aims to measure the environmental impacts of the food used by the Nutrition and Dietetics Service at Hospital de Clínicas (HC) in Montevideo, by assessing environmental footprints and eco-efficiency.

2 METHODOLOGY

This study was carried out at the Nutrition and Dietetics Service of the HC of Montevideo, Uruguay, and the institution provided the information. This is a retrospective study, considering the year 2021 and the first half of 2022, with a quantitative focus and using secondary data. The criteria for selecting the location was for convenience for investigation, in addition to its reference to free access to the health system by the population.

2.1 INCLUSION CRITERIA

To carry out the research, all foods the HC used in preparing meals offered to patients orally were considered. Therefore, dietary supplements used by enteral route were not included. The foods were classified according to their origin: animal or vegetable.

Regarding the raw materials used, the consumption amount of each food was verified in absolute values in kilograms (kg) per quarter. To select the items investigated for the calculations, this study considered the ABC curve criterion. Thus, the foods were grouped until they reached over 90% of the quantity purchased according to the period investigated. These foods make up the “AB” portion of the ABC curve. After the foods were identified and quantified, they were distributed into groups according to their characteristics.

The concept and use of the ABC curve method emerged in the 19th century with the Italian Vilfredo Paretto. In the ABC curve criterion classification, the items are separated by greater importance or impact in relation to those used in smaller quantities (Yan *et al*., 2013). Other studies in the collective feeding sector have previously used this criterion (Ribeiro *et al*., 2021; Strasburg; Jahno, 2017b; Strasburg *et al*., 2021). The Results section will present information on the totals of the items and the specification of the foods investigated.

2.2 VARIABLES INVESTIGATED

To carry out this research, the following variables were considered:

A. Quantity of inputs used is expressed in kilograms (kg): the net products were converted according to their volume to the equivalent in kg; for example, 1 litre of milk = 1 kg of milk.

B. Caloric value, variable represented in kilocalories (kcal): for industrialised products, this study verified the information on the nutritional labelling of the items used and that available in the HC stock. For products considered in natura, reference data from the "Brazilian Food Composition Table (TACO)" (Nepa, 2011) was used;

C. Financial value: the amounts paid by HC for products in Uruguayan pesos (UY$), which is the country's national currency, were considered;

D. Residues of the Edible Parts Index (Repi) of food, a variable expressed in kg: for this, each food's percentage of use (edible part) is considered. The database for performing the calculations was the MenuControl website (2022);

E. Water footprint (WF), as a unit of measurement, the litre (L): the study by Mekonnen and Hoekstra (2012) was used as a reference for products of animal origin, and also by Pahlow *et al*. (2015) in the evaluation of fish; for foods of plant origin, the database was the study by Mekonnen and Hoekstra *et al*. (2011);

F. Carbon Footprint (CF), a variable that is measured in carbon dioxide equivalent (CO2e): the basis for consultation was the Healabel website (2022a);

G. Ecological Footprint (EF) and global hectares (gha) are used as the unit of measurement; the reference value information was obtained from the Healabel website (2022b);

H. Greenhouse Gases (GHGs): to calculate the emission, it was necessary to verify the distance in kilometres (km) of the investigated food, considering the place of origin (production or packaging) of Montevideo. The website "Distance between cities" (Wepoke, 2022) was used for this. For GHG emissions and convenience in the transportation of products, this study considered a truck-type vehicle with a diesel engine (diesel), which emits 0.53912 kgCO2e per km travelled, according to the Department of Energy & Climate Change (DECC, 2020) website.

2.3 ECO-EFFICIENCY (EE) CALCULATIONS

The formula for calculating EE was developed by the World Business Council for Sustainable Development (WBCSD, 2000):

$$EE = \frac{\text{value of the product or service}}{\text{Environmental influence}}$$

The EE calculations aim to more accurately assess the environmental aspects (product value) and impacts (influence) of the inputs used in this research. The following items were considered as variables for the "value of product or service": a) quantity of inputs used (kg), b) caloric value (kcal), and c) economic value (UY$). For the environmental influence, the following items were used: "e" (WF), "f" (CF), "g" (EF) and "h" (GHG).

Twelve different calculations were carried out, which are presented in Chart 1. For each aspect, one of the environmental impacts was considered.

Chart 1 – List of Eco-efficiency calculations of inputs used at the Hospital de Clínicas, Montevideo.

Aspect	*Impact*	*EE Formulas*
Kg	WF	kg (WF/nº ap)
Kcal		Kcal (WF/nº ap)
UY $		UY $ (WF/nº ap)
Kg	CF	Kg (CF/nº ap)
Kcal		Kcal (CF/nº ap)
UY $		UY $ (CF/nº ap)

Aspect	Impact	EE Formulas
kg	EF	kg (EF/nº ap)
kcal		Kcal (EF/nº ap)
UY $		UY $ (EF/nº ap)
kg	GHG	kg GHG
kcal		kcal GHG
UY $		UY $ GHG

Nº ap = Number of appointments.
Source: The authors.

Finally, a consolidated equation was created considering all the variables and expressed in the following formula:

$$EE = \frac{\text{value of the product or service}}{\text{Environmental influence}} = \frac{(kcal \times UY\,\$) / kg}{(WF + CF + EF + REPI + GHG)}$$

2.4 DATA ANALYSIS

The results of the data were transcribed into Microsoft Excel© 2010 to calculate absolute frequencies, percentages, means, and standard deviation. For statistical analysis, Friedman's test was used, which is a non-parametric test used to compare linked sample data. The software used was R Project © version 4.1 (2021), with a significance of 5%.

2.5 ETHICAL ISSUES

There was no direct intervention with human beings, thus renouncing the use of the Informed Consent Form. The project is part of a postdoctoral research project and was approved by the committee of the Faculty of Sciences of the University of the Republic (Udelar) in February 2022.

3 RESULTS

In the period investigated, the HC served 317,380 meals that were distributed semiannually, as follows: a) 2021/1= 94,684; b) 2021/2= 114,235; 2022/1= 108,461. These values consider all types of food, and hospitalised patients are given at least four meals a day: breakfast, lunch, afternoon snack, and dinner. Regarding the inputs used, Table 1 presents the distribution according to the AB curve criterion. Chart 2 presents the specifications of the food groups.

Table 1 – General evaluation of using the AB curve for admissions of the Hospital de Clínicas, Montevideo.

Year	2021			2022 (first semester)		
Foods	*items*	*kg*	*%*	items	Kg	%
General	90	429.336	100	83	224.373	100
AB curve	38	409.277	95,33	38	216.027	96
Animal – AB curve	8	135.656	31,6	8	72.012	32
Vegetable – AB curve	30	273.621	63,73	30	144.014	64
C curve	52	20.059	4,67	52	8.347	4

Source: The authors.

Chart 2 – List of foods from each group used at the Hospital de Clínicas, Montevideo/UY.

Food Groups	*Items*
Meats and eggs	bovine: rump and shoulder; fish; chicken breast; eggs
Dairy products	milk: whole and skimmed; grated cheese
Sugar, oil, sweets	sunflower oil; tomato pulp; sugar; quince and pumpkin jams
Cereals, flours, breads	parboiled rice; flours: wheat and corn; pasta noodles; cookies; bread and bread without salt
Fruits	banana, peach, tangerine, apple, orange; pear
Processed vegetables	sweet potato; potato; carrot; pumpkin
Natural vegetables	chard; onion; lettuce; bell pepper; leek; beet; tomato; zucchini

Source: The authors.

As it is a public hospital, supplies are obtained through bidding by suppliers. This study found that all HC suppliers were from Montevideo. However, the origin of the raw materials, which can be identified by the product's packaging, had different origins. Fresh fruits and vegetables were the only food group for which it was impossible to verify such information.

From the meat and eggs group, beef was identified. It originated in different Brazilian cities, as well as in Paraguay, and it competes with local meat at lower prices. In turn, fresh fish, chicken, and eggs are produced by Uruguayan companies. The same applies to the whole range of dairy products, including those that are not considered for inclusion in the “AB” extract criteria of the ABC curve.

The origin of items in the sugars, oils, and sweets groups, as well as cereals, flours, and breads, was identified in Uruguay. However, in fact, it is impossible to know if all the inputs used in the products’ production really come from the country.

Regarding processed and fresh fruits and vegetables, the origin of Uruguayan cities can be seen in the packaging of some products. However, it is noteworthy that the fruit most used by the HC, bananas, was imported from Brazil. Likewise, there is no way to carry out a traceability process to identify the eventual origin of fruits and vegetables from Argentina or another region.

Although they are not included in the classification criteria for the “AB” extract of the ABC curve, the origin of other foods is worth being registered. Frozen vegetables like peas, corn, and beans came from Turkey. Instant coffee in sachets came from Peru. Industrialised shredded tuna, on the other hand, originated from Ecuador. Peach candy in syrup was produced in Vietnam, and vegetables such as lentils originated from Canada.

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Regarding the variables of this study, Table 2 verifies the consolidated results in absolute values and percentages of the environmental aspects and impacts of the food groups.

Table 2 – Absolute values and percentages of the variables according to the food groups used at the Hospital de Clínicas, Montevideo/UY.

Food Groups	*Amount* Kg	kcal total	UY $ total	REPI Total	"WF –L" total	CF – CO2e total	"EF -ga" total	GHG km
Meats and eggs	79.770,72	177.302,53	19.777	6.25	926.692,12	1.691	14.094,54	6.370
Dairy products	128.680	87.595	5.033	0.00	141.025,00	273	1.330	213.492
animal origin total	208.450	264.898	24.811	6.25	1.067.717,12	1.963	15.425	6.583.464
Total % Animal	33	36	52	11,25	73,99	88	90	81
% Animal total	27.578	106.886	1.937	0.00	77.890,58	91	322	472.269
Sugar, oil, sweets	82.964	251.199	6.802,43	0.00	153.900,01	86	475	168.204
Cereals, flours, breads	116.099	43.467	3.945	31.06	89.165	27	437	742.368
Fruits	122.527	66.634	7.993,69	0,00	35.407,40	40	390	64.695
Processed vegetables	68.467	8.335	1.992,50	18.24	18.959,84	22	139	129.390
Natural vegetables	417.635	476.521	22.670,28	49.31	375.323,28	265.78	1.763	1.576.926

Food Groups	*Amount*	kcal	UY $	REPI	"WF –L"	CF – CO2e	"EF -ga"	GHG
	Kg	total	total	Total	total	total	total	km
vegetable origin total	66,71	64,27	48	88,75	26	11,92	10	19
% Vegetable total	66,71	64,27	48	88,75	26,01	12	10,26	19
GENERAL TOTAL	**626.085,86**	**741.419,24**	**47.481**	**55.56**	**1.443.040,40**	**2229.21**	**17.188,15**	**8.160.390**

Source: The authors.

Below are the results of the statistical tests used to evaluate the consumption of the food groups for each of the quarters (Table 3).

Table 3 – Friedman test: Quantity in kg and water footprint of the food groups used at the Hospital de Clínicas, Montevideo/UY.

Food Groups	*n.*	*Median*	*Df*	*p-value (kg)*	*p-value (WF)*
Meats and eggs	5,00	14,3	5	**0,0141**	0,0141
Dairy products	3	10	5	0,0739	0,0739
Sugar, oil, sweets	5	9,23	5	0,1000	0,1000
Cereals, flours, breads	7	15,7	5	**0,0079**	0,0079
Fruits	6	2,12	5	0,8320	0,8320
Processed vegetables	4	11	5	0,0514	0,0514
Natural vegetables	8	7,71	5	0,1730	0,1150

Source and highlight in bold: The authors.

In evaluating the variables amount of consumption and water footprint, the same two food groups showed significant differences, p ≤0.05, when the comparative evaluation was carried out by quarter. Thus, the alternative hypothesis (H1) is accepted that in these groups, the median kg consumed and the WF in the comparison between inputs and the quarter are significantly different from the foods of the other groups.

The Kruskal-Wallis test was also applied to evaluate GHG emissions according to food groups, with chi-square = 5.1101, gl = 1, and p-value = 0.02379. In terms of their origin, animal, and vegetable, there were significant differences among the food groups, (p ≤ 0.05) when comparing GHG emissions with the type of food and its origin. The following tables show the information related to Eco-efficiency calculations according to the associations between variables of aspects and impacts (Tables 4 and 5).

Table 4 – General evaluation of Eco-efficiency considering the water and carbon footprints of the food groups used in the Hospital de Clínicas, Montevideo/UY.

Food Groups	*"Kg (WF/nº ap)"*	*"Kcal (WF/nº ap)"*	*"UY $ (WF/nº ap)"*	*"Kg (CF/nº ap)"*	*"Kcal (CF/nº ap)"*	*"UY $ (CF/nº ap)"*
Meats and eggs	27,32	60723,81	6773,52	14973,06	33279901,18	3712252,97
Dairy products	289,60	197135,19	11327,51	149846,12	102003725,46	5861199,30
Animal origin total	61,96	78741,14	7375,02	33695,16	42819643,44	4010554,10
Sugar, oil, sweets	112,37	435528,19	7890,71	96519,68	374091877,79	6777630,91
Cereals, flours, breads	171,09	518035,25	14028,29	305672,52	925514306,32	25062744,28
Fruits	413,25	154720,03	14042,55	1365859,23	511378347,48	46413222,35
Processed vegetables	1098,29	597282,15	71652,76	966237,65	525467054,71	63037483,97
Natural vegetables	1146,12	139521,50	33353,59	999604,85	121686046,69	29089897,44
Vegetable origin total	353,16	402954,94	19170,39	498704,18	569020777,51	27070890,30
GENERAL TOTAL	**137,70**	**163066,56**	**10442,90**	**89137,73**	**105558089,66**	**6760015,41**

Nº ap = Number of appointments. Source: The authors.

Table 5 – General Eco-efficiency assessment considering the ecological footprint and GHG impacts of the food groups used at the Hospital de Clínicas, Montevideo/UY

Food Groups	*"Kg (EF/nº ap)"*	*"Kcal (EF/nº ap)"*	*"UY $ (EF/nº ap)"*	*"Kg GHG"*	*"Kcal GHG"*	*"UY $ GHG"*
Meats and eggs	1796,27	3992488,24	445347,67	12,523	27834,115	3104,795
Dairy products	30699,33	20897743,86	1200797,73	602,739	410298,308	23576,003
Animal origin total	4289,05	5450499,85	510502,25	31,663	40236,844	3768,645
Sugar, oil, sweets	27155,81	105250754,46	1906886,54	58,394	226324,825	4100,453
Cereals, flours, breads	55426,37	167819795,98	4544526,87	493,235	1493416,160	40441,414
Fruits	84371,18	31588608,19	2867014,42	156,390	58552,342	5314,271
Processed vegetables	99707,66	54223814,07	6504942,18	1893,927	1029970,223	123560,042
Natural vegetables	156166,65	19010814,48	4544667,68	529,157	64416,466	15399,205
Vegetable origin total	75172,23	85771408,14	4080533,56	264,841	302183,758	14376,247
GENERAL TOTAL	**11560,71**	**13690344,76**	**876739,45**	**76,723**	**90855,859**	**5818,474**

Nº ap = Number of appointments. Source: The authors.

Table 6 and Figure 1 present the consolidated assessment, which calculated all aspects related to environmental impacts

Table 6 – Consolidated eco-efficiency by semester according to the food groups used at the Hospital de Clínicas, Montevideo/UY..

Food Group	*2021/1*	*2021/2*	*2022/1*	*Total*
Meats and eggs	55,9219	54,9955	**30,9572**	46,6407
Dairy products	24,4203	23,6409	24,0219	24,0224
Total Animal Origin	**32,4009**	**32,4363**	**22,7080**	**29,0562**
Sugar, oil, sweets	96,1654	94,7737	**96,5099**	95,8516
Cereals, flours, breads	133,8678	133,6015	132,6168	133,343
Fruits	16,2548	16,7103	16,4346	16,4739
Processed vegetables	121,0566	120,3319	122,5190	121,302
Natural vegetables	13,1203	12,1157	12,7875	12,6733
Total Vegetable Origin	**67,6662**	**69,1699**	**68,6998**	**68,5388**
GENERAL TOTAL	**39,6694**	**40,5503**	**35,3239**	**38,4457**

EE = aspects (kcal x UY$ / kg)

Impacts (WF + CF + EF + REPI + GHG)

Source: The authors

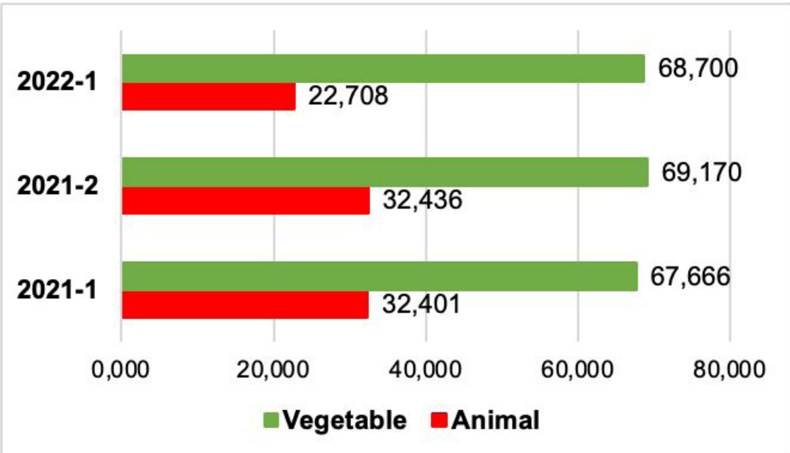

Figure 1 – Consolidated assessment of EE per semester according to the origin of the food used at the Hospital de Clínicas, Montevideo.

Source: The Authors.

4 DISCUSSION

The standardisation of menus and foods used is usually associated with the population's consumption habits, conferring it a cultural identity (Uruguay, 2019). Foods used in meal preparation have specific uses. As for the degree of food processing, almost all of them can be classified as fresh or minimally processed, according to the Food Guide for the Uruguayan population (Uruguay, 2019).

Regarding the results presented in Table 2, the REPI values were directly related to products of plant origin, especially those received in natura. A study that evaluated the use of plant inputs in a Brazilian hospital found that it would be necessary to purchase 25.6% more vegetables if they were not purchased in the processed modality (Melo; Strasburg, 2020). At Montevideo's HC, processed vegetables contribute to a lower use of water, disinfectants, and workers involved.

As for the other aspects and impacts, the table shows that the two groups of foods of animal origin represented 33.3% of the total in kg and 52.3% of the economic value. However, concerning the environmental impacts of footprints, the values varied between 74% and 89.7%, depending on each footprint evaluated. This group was also responsible for 80.7% of total GHG emissions, mainly due to the origin of inputs.

This fact is especially due to the hospital's use of beef, which was the most used item in the meat group and also presents the highest values for two environmental impacts: WF and GHG emissions. The WF of beef is nearly 15,000 litres per kg of product (Mekonnen; Hoekstra, 2012), and the GHG emission value is also due to the product being imported from Brazil and Paraguay.

The results of the HC show a similarity between the values of environmental footprints. Other studies corroborate results similar to those found for HP in this study, with values ranging from 64.2% to 77.9% (Hatjiathanassiadou *et al*., 2019; Strasburg; Jahno, 2015; Strasburg *et al*., 2021).

From a general perspective of environmental impacts, studies indicate that there is a direct relationship between the amount of excessive consumption of animal products with the relevant environmental impacts on land use and biodiversity loss, water use, carbon footprint, energy demand, and GHG emissions (Aleksandrowicz *et al*., 2016; Bengtsson *et al*., 2019). In turn, Hölker *et al*. (2019) point out the need for having a considerable reduction in the consumption of foods of animal origin, listing reasons involving animal welfare, human health, and environmental issues.

On the other hand, the negative effects must also be considered in terms of the form of plant production, especially with the use of pesticides. Its adverse effects interfere with soil, water, plant metabolism, the reduction of pollinating insects, and human health (e.g., cancer, allergies, and asthma) (Pathak *et al*., 2022). Mahmood *et al*. (2016) also point out that the excessive use of pesticides can lead to the destruction of biodiversity, threatening several plants and animals' species. Therefore, it is a concern for environmental sustainability and global stability.

Concerning the five groups of products of plant origin, this study identified a predominance of the inputs investigated as coming from the country itself. Thus, the environmental impacts were lower in relation to GHG issues. Purchasing and using locally produced food give advantages such as reduced supply distances, hence, lower GHG emissions. Besides, it offers more opportunities to improve the living conditions of rural workers, promoting the local economy (Nogueira *et al*., 2020).

The use of the quantity (kg) of some products is more evident with the seasonality of these articles in relation to the quarters, as well as the impact of the WF, which was statistically evident when applying the Friedman test in Table 3.

The EE calculations presented in Tables 4 and 5 allow a more detailed comparative evaluation of the elements analysed. The results corroborate the findings consolidated in Table 2 and can serve as an evaluative tool for decision-making regarding the relationship between variables according to food groups. Generally, the proportion of EE of animal products tends to be worse than that of plant products.

This resource can be used to search for alternatives regarding the use of certain foods and the quantity used, making it possible to plan new menus to reduce the environmental impacts of the hospital food service. The first study focused on collective food, evaluating the EE of raw materials in university restaurants, and the best results found were directly related to the types of food and the amount used in each location (Strasburg; Jahno, 2017b).

A study with school menus highlighted the importance of evaluating the energy value of the meals offered and their environmental impacts (Volanti *et al.*, 2022). In this sense, EE responds fully. Other research on hospital food services has used EE to verify environmental impacts such as GHG emissions in enteral diets, complementary foods, and breakfast items in pediatric units (Ribeiro *et al.*, 2020; Strasburg *et al.*, 2022).

Uruguay is a country that has a solid agricultural base in food production and is primarily known for the quality of its animal products, such as meat and dairy products, which are mostly exported (Alberto, 2019; Saadoun; Cabrera, 2013).

The general results of this research made it possible to observe a strong influence of environmental impacts due to the use of products from other countries. Globalisation has separated the relationship between countries regarding the choice and consumption of *commodities* for those who import, and the amounts received for those who export (Jia, 2021). Food is considered an essential item and has undergone a globalisation production process, having moved about 1,392 billion dollars in 2019 (FAO, 2020).

In the case of Uruguay, its territorial extension is one of the smallest in Latin America. Its geographical location in the extreme south of the continent also makes it impossible to have suitable climatic conditions for some products. A study by Alberto (2019) indicated that 32% of the total calories produced in the country went to animal feed. Additionally, the production of fruits and vegetables would only be enough to supply 50% of the population, considering the appropriate consumption recommendations.

Agricultural and livestock production faces new challenges, with the demand to safely and nutritiously feed a world population that continues to grow on the planet (Balogh; Jámbor, 2020). In addition to generating jobs and income, agriculture ensures the sustainability of natural resources and biodiversity, especially regarding climate change (FAO, 2018). This occurs because changes in weather patterns, provoked mainly due to rising temperatures and decreasing or increasing rainfall, have affected the agricultural sector. This way, adaptive and climate-resilient crops associated with new technologies become an alternative to regular food production (Machili, 2020).

Dalin and Rodríguez-Iturbe (2016) point out in their systematic review of the environmental impacts on water and soil use, pollution, and GHG emissions in the global food trade. Some authors claim that the planet will suffer serious consequences if there are no major changes in food production systems in terms of GHG emissions, agricultural land use, and freshwater by 2050 (Steffen *et al.*, 2015; Willett *et al.*, 2019).

This study considered the limitations of the databases that were used to evaluate the values of some variables obtained from tables in the scientific literature, such as environmental footprints (WF, CF, and EF) and caloric values. The data from these records serve as a reference for a food, expressing a trend and not an exact value. This is because each type of food has characteristics and specificities related to the research schedule, in addition to the interference of a geographical context such as location, soil type, and climate (Carmo *et al.*, 2007). As the article emphasised environmental footprints, it was impossible to investigate other issues that negatively impact the environment, such as the use of pesticides in the production of plant products.

However, the contributions of this study apply to contexts of other food services, especially in the hospital environment, and which can be applied, enabling collaborative research with other countries and continents. We also highlight other possibilities for investigating the environmental footprints of enteral nutrition and supplementation products used in hospitals that have been evaluated in other studies (Strasburg *et al*. 2024a; Strasburg *et al*., 2024b).

5 CONCLUSIONS

This study presented an investigation of the environmental impacts of the food used by the Hospital de Clínicas between 2021 and the first half of 2022. Thus, it highlights the representativeness of the ABC curve method for the survey of inputs used. It was possible to identify the impact of animal products in terms of economic value and also the negative impacts of water, carbon, ecological footprint, and GHG generation due to the place of origin of these foods, especially beef. Plant-based products came, for the most part, from Uruguay, implying lower impacts when compared to imported ones.

Despite having surplus agricultural production, Uruguay exports much of its food due to a commercial expansion strategy beyond the domestic market and, obviously, the characteristics of globalised economies. However, some foods are imported due to production deficiencies or commercial conditions, which affect the environmental and GHGs footprint results, corroborated with eco-efficiency calculations.

Concerning collective food services, especially hospitals, the various types of environmental impacts due to the amount and types of food used in the preparation of menus, in addition to attention to nutritional aspects, can also be considered to collaborate with the sustainability of the planet. Other studies of this nature in food services are suggested, in general, to collaborate with research on this topic.

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