Review Article

WM&R

Waste Management & Research
2023, Vol. 41(2) 285–302

DOI: 10.1177/0734242X221122604
journals.sagepub.com/home/wmr


Sustainability in food service: A systematic review

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Abstract

The irrational functioning of the food sector can negatively impact the environment and resources for future generations. The aim of this study is to analyse the assessment of sustainability indicators related to meal production processes and waste in the food service through a systematic literature review. The hypothesis is that these indicators are still little explored. This review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols. The databases consulted were Lilacs, Science Direct, Scientific Electronic Library Online (SciELO), *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*, OpenGrey and Greylit. Six different search strategies were applied, combining the terms sustainability and food service, plus manual searches. The search took place until April 2020 and there was no language restriction of the studies. After removing duplicates, 770 publications were identified through the search process, with 44 having been included in this review. Most publications carried out the quantification of food waste (38/44), while in 7/44 there were questionnaires, checklists and water footprint assessments. Most studies identified high indicators of waste, as well as little awareness of sustainability. Factors such as controlled portioning, omnivorous menus and dissatisfaction with the menu were reported to have caused the greatest losses in the process. This review identified a restricted assessment of sustainability in food service, countering the need to deepen these indicators and the effect of meal production processes on sustainable development.

Keywords

Waste, food service, food waste, sustainable development indicators, systematic review, sustainable consumption

Received 18th January 2022, accepted 13th June 2022 by Associate Editor Antonis A. Zorpas.

Introduction

Food service is economically and socially important, for it support related businesses, creates jobs, enables the provision of meals for different communities, and generates high financial value (Lima and Borges, 2020). According to the Brazilian Association of Collective Meals (Associação Brasileira Das Empresas De Refeições Coletivas, 2020), in 2019, the sector provided 21.84 million meals per day, employed 250 thousand employees, and had revenues of R$52.02 billion.

Although the meal production process does contribute to the economy and society, operations carried out in food service can have a negative impact on the environment, when there are limiting physical structures, excessive consumption of natural resources and absence of waste control measures, compromising the resources for future generations (Brasil, 2006; Dias and Oliveira, 2016).

Natural resources, such as water, are used in multiple stages of food production, as in food hygiene and cooking, as well as in the cleaning of equipment, utensils and physical structure. Electricity is necessary for the overall functioning of food service, particularly for machinery, which can also use gas as the main fuel for generating heat. In addition, there is a high production of solid waste, especially in the pre-preparation stages, due to poor quality of the products employed or inadequacy of handling techniques, in addition to losses of food in production and to leftovers and food scraps that remain after distribution (Araújo and Carvalho, 2015; Strasburg and Jahno, 2017a). The abusive use of natural resources and loss and waste of food are considered important sustainability indicators (Food and Agriculture Organization of The United Nations [FAO], 2011).

According to the Food and Agriculture Organization (FAO, 2011), one third of the edible parts of food are lost or wasted worldwide, amounting to roughly 1.3 billion tons per year. In addition to a broad environmental impact, such waste costs the equivalent of US$ 750 billion.

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Against this worrying and challenging scenario, the Sustainable Development Goals (SDG) were proposed to encourage actions in favour of responsible production and consumption (Organização das Nações Unidas [ONU], 2015). In Brazil, Law No. 12,305 of 2010 established the National Policy on Waste Management, assigning to people or institutions the duty to carry out the proper management of waste, so that there is no damage to the environment, demonstrating that sustainable development is legally relevant and of national concern (Brasil, 2010). Other initiatives were observed in different countries to prevent waste and to promote sustainability (Stone et al., 2019; Zorpas et al., 2014, 2015).

Given the above, this study aims to analyse the assessment of sustainability indicators related to meal production processes and waste in the food service through a systematic literature review. Its objective is to identify the generally sustainability indicators used in the meal production processes and its impacts on sustainable development. The hypothesis is that although the assessment of sustainability indicators has been increasing in the food service, it is still very superficial and explored.

Materials and methods

This systematic review included studies published until April 2020 in any language. The search and selection of suitable studies was conducted according to the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-Analyses – PRISMA (Moher et al., 2015). A research protocol and data collection forms were structured accordingly.

Publications from different parts of the world, presenting original data, an observational design, and the assessment of sustainability practices in food service were included in this study. The exclusion criteria were review papers, qualitative studies, intervention studies and publications in the form of comments and letters. These, however, were used to search and select publications manually.

We consulted the databases Lilacs, Science Direct and Scientific Electronic Library Online (SciELO) and conducted a manual search by checking the reference lists of the publications found. In addition, grey literature was consulted in the databases OpenGrey and Greylit, and in those of the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*.

Six search strategies were used, combining the following terms: (1) 'sustainability' AND 'food service'; (2) 'waste' AND 'food service'; (3) 'food service'; (4) 'food service' AND 'sustainability' OR 'waste'; (5) 'waste' and 'feeding'; (6) '*desperdício*' AND '*alimentação*'.

The search and selection of publications was carried out independently by two reviewers (FCC and LOF), according to the eligibility criteria and in accordance with the predefined protocol. Any disagreements were settled by consensus or in consultation with a third reviewer (DAS).

Following search and selection, duplicate articles were identified and removed. To begin with, we evaluated the titles of the articles selected, and those deemed eligible for this review had their abstracts analysed. Next, articles that met all the inclusion criteria were selected for full reading. We must disclose that when an article could not be accessed in its entirety, the authors were approached with a request for the full-text publication.

The studies included in this review had their information characterized through a standardized instrument, by extracting data on the country where the study took place, authors and year of publication, type/location of the establishment, public served, sustainability assessment method, data collection period, study goal, data analysis method and results found.

Information on the search process and resulting evaluations were saved in Microsoft Excel® spreadsheets, and the study protocol and tables were prepared using Microsoft Word®.

The methodological quality and subsequent risk of bias of the studies were analysed using the Critical Appraisal Checklist for analytical cross-sectional studies of the Meta-analysis of Statistics Assessment and Review Instrument (MAStARI), developed by Joanna Briggs Institute (Moola et al., 2020). This instrument was adapted according to the aim of this study that implies cross-sectional studies realized in collective food services and based on Falcomer et al. (2018). The bias risk instrument included seven questions that are listed below.

1. Was the analysed food service institution characterized?
   The authors should provide clear information about characteristics of food service institution (e.g. type of institution, place and number of meals produced).
2. Was the selected institution representative and randomly determined?
   The authors should provide detailed information about the selection process of the institution (e.g. convenience or random selection).
3. Was the data collected described in detail?
   The authors should provide detailed information about the process of data collection (e.g. date and duration of collection, equipment or instruments used).
4. Have the sustainability measure been specified?
   The authors should provide clear description of the type of sustainability measure (e.g. weighing, check-list or/and interview).
5. Was the sustainability measure in a valid and reliable way?
   The study should clearly describe the method of measurement of sustainability, considering the weighing of foods or validated questionnaires as 'gold standard'.
6. Was an appropriate statistical analysis used?
   The methods section should be detailed enough about statistical methods used to compare the data.
7. Did the results answer the main question?
   The study should present results according to the main objective.

After the evaluation, the risk of bias was categorized as 'High' when the study reached up to 49% score 'yes'; 'Moderate', when

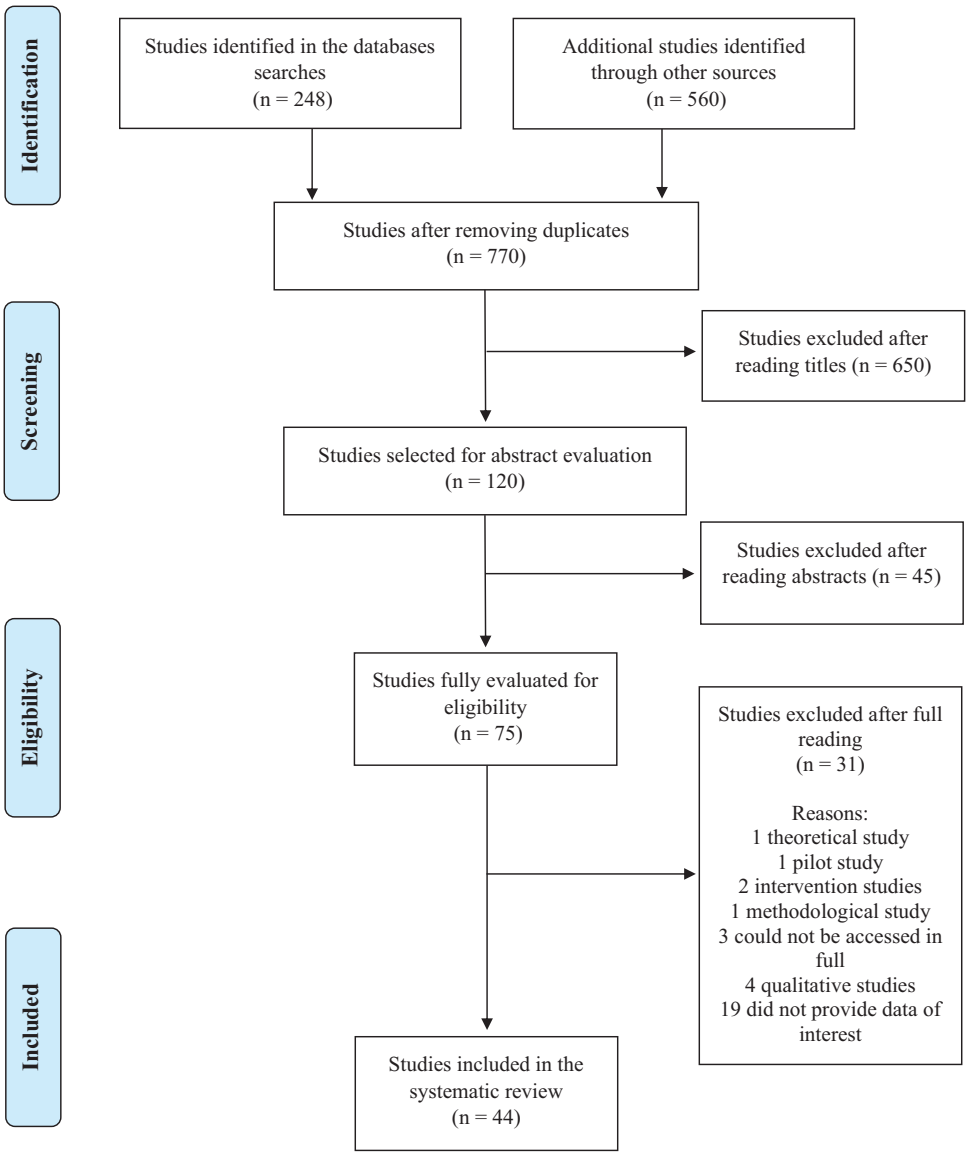

Figure 1. Flowchart of the study selection process: identification, screening, eligibility and inclusion of studies in the systematic review, as PRISMA (2015).

the study reached 50%–69% score 'yes'; and 'Low', when the study reached more than 70% score 'yes'.

Results

The search process resulted in 808 publications: 135 from the Science Direct database, 28 from Lilacs and 85 from SciELO, in addition to 509 from grey literature and 51 from manual search. Thirty-eight duplicate articles were identified and, after all the evaluation steps, 75 were read in full. Of these, 31 were excluded for the following reasons: 1 theoretical study, 1 pilot study, 2 intervention study, 1 methodological study, 4 qualitative studies, 19 studies that did not contain data of interest and 3 studies in which the full-text was not available. Finally, 44 articles were included in this review. A flowchart detailing the search and selection process is shown in Figure 1.

Table 1 shows the characterization of the studies included in this review. Studies from four different continents were identified: Africa (1/44), Asia (4/44), America (33/44) and Europe (7/44). The majority of publications came from Brazil (32/44) and were published from 2004 on, focusing mainly on the last 5 years (29/44). It is worthy of note that there was a predominance of scientific articles (43/44), in addition to Master of Science dissertations (2/44).

Most studies were conducted in institutional food service (38/44), particularly hospitals (9/44), schools/day-care centres (9/44) and universities (8/44). The samples included mostly workers (17/44) and students (7/44). The most common sustainability assessment methods were the quantification of solid waste (38/44) and the application of standardized questionnaires adapted by the authors (9/44), with varying evaluation periods (Table 1).

Table 1. Characterization of the studies included in the systematic review as to the type/location of institutions, clientele, forms and period of sustainability assessment.

Country	Author (year)	Type/location of institutions	Clientele	Forms of assessment of sustainability	Period of assessment
Pakistan	Aamir et al. (2018)	Commercial/*buffet* and a-la-carte restaurants	NA	**Questionnaire:** adapted from Quested and Parry (2011) and FWRA (2016). completed by the restaurant's chief manager or chef, followed by a qualitative interview.	NA
Qatar	Abdelaal et al. (2019)	Commercial/coffee shops, chain stores, pizzeria, bagel shop, Arab bakery/cafe, frozen yogurt shop and a snack bar Institutional/*buffet* and a-la-carte restaurants	Students	**Weighing:** the garbage bags were labelled based on their origin and every day the bags were weighed and then opened to identify or confirm the nature of the waste (avoidable or unavoidable waste).	October and November 2016 and January and February 2017
Brazil	Abreu et al. (2012)	Institutional/hospital	Staff, patients, resident doctors, university students and companions	**Weighing:** rest-intake and leftovers.	5 days
Brazil	Alves and Ueno (2015)	Institutional/company	Staff	**Weighing:** solid waste generated in the production of meals divided into organic waste (from food), nonrecyclable waste (paper towels and greasy napkins) and recyclable waste (paper/cardboard, plastic, tin, glass). **Questionnaire:** routine regarding the selection, weighing and destination of solid waste.	5 days
Brazil	Aranha and Gustavo (2018)	Institutional	NA	**Weighing:** meals produced, distributed and leftovers. **Calculation:** percentage of leftovers, weight of leftovers per customer, percentage of rest-intake and per capita of rest-intake.	From 22 March to 5 April 2016
Brazil	Araújo and Carvalho (2015)	Institutional/company	Workers in administrative and operational positions	**Weighing:** quantification of residues from the receipt of raw materials, storage, pre-preparation and preparation, and even after distribution. **Questionnaire:** according to the model used by the Meal Production Research Center at the Federal University of Santa Catarina to identify actions that contribute to sustainability, answered by the unit's nutritionist.	20 days
Brazil	Beal et al. (2018)	Institutional/hospital receiving transported meal	Healthy and sick collectives	**Weighing:** rest-intake and dirty leftovers related to the healthy community and rest ingestion of the sick community.	2 weeks
Sweden	Betz et al. (2015)	Institutional/two companies served by the same large catering company. Company A is located in the education sector and company B is in the business sector	Catering for employees	**Weighing:** remaining intake and leftovers. **Questionnaire:** anonymous, with mostly closed questions. It was used to collect data on customer opinions, divided into three sections: the first section on the canteen, the second on food waste in general and the third on sociodemographic data.	5 consecutive representative days (in addition to storage losses, collected over a period of 4 weeks)
Brazil	Nonino-Borges et al. (2006)	Institutional/hospital	Patients and servers	**Weighing:** food scraps left on trays or plates.	14 days
Brazil	Canonico et al. (2014)	Institutional/popular restaurants	NA	**Weighing:** food produced, distributed and leftovers. **Calculation:** index of rest-intake, the percentage of clean leftovers and food waste.	8–12 July 2013
Brazil	Carvalho et al. (2013)	Institutional/company	NA	**Weighing:** distributed meal and leftovers. **Calculation:** rest-intake index calculated according to the methodology proposed by Abreu and Spinelli (2003).	10 days
Brazil	Copatti et al. (2018)	Institutional/hospital	Patients and companions	**Weighing:** food produced, distributed and leftovers. **Calculation:** rest-intake.	4 days
Portugal	Dias-Ferreira et al. (2015)	Institutional/hospital	NA	**Weighing:** general and preparation waste (soup, main course, fruit and bread). **Calculation:** percentage of remains.	September to October 2014 (8 weeks)
Brazil	Domingues et al. (2016)	Institutional/university	NA	**Weighing:** total weight of leftovers over the counter and other intake.	31 consecutive days
Sweden	Engström and Carlsson-Kanyama (2004)	Commercial/restaurants and institutional/schools	NA	**Questionnaire:** semi-structured interview with employees about their attitudes towards food losses and strategies to prevent and minimize them. **Weighing:** losses in storage and preparation, leftover dishes and kitchen scraps.	2 weeks
Sweden	Eriksson et al. (2017)	Institutional/nursing homes, schools and preschools	Schoolchildren and elderly	**Weighing:** wasted food and food served. Waste was categorized as serving waste (with subcategories), plate waste and other food waste.	3 months
Brazil	Fatel et al. (2018)	Institutional/hospital	Staff	**Weighing:** food produced, served and leftovers. **Calculation:** remaining intake and leftovers.	3 weeks
Brazil	Ferreira et al. (2012)	Institutional/child education centre	Preschoolers	**Weighing:** distributed meal and leftovers. **Calculation:** rest-intake and clean shade.	September 26th to 30th, 2011

(Continued)

Table 1. (Continued)

Country	Author (year)	Type/location of institutions	Clientele	Forms of assessment of sustainability	Period of assessment
Brazil	Galian et al. (2016)	Institutional/company	NA	**Weighing:** The analysis of waste was carried out by checking the amount of meal produced and the clean leftovers. **Calculation**: remainder ingested according to Silva et. al. (2010).	5 days (June to October 2015)
Brazil	Halmenschlager (2017)	Institutional/hospitals	NA	**Calculation:** performed by the total adequacy and the total inadequacy. The two totals were added up to obtain the grand total. The classification of Unidades de Alimentação e Nutrição (UANs) according to good environmental practices followed the proposal of Veiros (2009), and adapted by the author. **Checklist:** elaborated and tested by Colares; Colares et al. (2014). **Questionnaire:** answered by the institution manager or person designated by him, elaborated and structured with open and closed questions based on adaptations of ABNT-NBR ISO 14001 (BRASIL, 2004), and consult the works of Tayra and Ribeiro (2006) and Lyra (2008).	NA
Brazil	Hatjiathanassiadou et al. (2019)	Institutional/universities	College student and staff	**Water footprint:** verification of the origin of the food purchased to compose the 2-month menu.	March to April 2018 (2 months)
Brazil	Issa et al. (2014)	Institutional/schools	Schoolchildren	**Weighing:** gross and net weight of all ingredients, weight of preparations, clean leftovers, dirty leftovers, rest-intake and weight of portions consumed by employees. **Calculation**: rest-intake according to Vaz (2003).	From March 2011 to April 2012
Brazil	Juffo et al. (2016)	Commercial/shopping mall restaurants	NA	**Weighing:** Solid organic waste.	4 days
Brazil	Longo-Silva et al. (2013)	Institutional/public day-care centres	NA	**Weighing:** portions of each food and/or preparation. **Calculation:** average value served to each child and rest-intake index.	From September to December 2010
Brazil	Mello et al. (2011)	Institutional/club	Operational and administrative staff	**Weighing and Calculation:** Data were obtained regarding the number of customers, the quantity of meal distributed, the consumption per capita per meal, the rest, the rest per capita and the rest index.	From September to November 2008
Brazil	Moura et al. (2009)	Institutional/vocational education centre	NA	**Weighing:** meal produced and leftovers. **Calculation:** rest-intake according to Vaz (2003).	31 March to 17 April 2009 (7 days)
South Africa	Painter et al. (2016)	Institutional/university	NA	**Weighing:** food waste generated daily in cafeterias. **Online questionnaire:** to gain insight into students' eating habits and their perceptions of the reasons behind food waste.	21 days
Malaysia	Papargyropoulou et al. (2019)	Commercial/*buffet* and a-la-carte restaurants Institutional/university	Local families, tourists, students and staff	**Weighing:** avoidable and unavoidable waste, preparation waste, rest-intake and buffet remains (leftovers).	1 week
Brazil	Pospischek et al. (2014)	Commercial/self-service restaurants	General	**Questionnaire:** interview with the owner or manager of the establishment using a questionnaire with open and multiple choice questions adapted to that proposed by Bilck et al. (2009)	NA
Brazil	Ricarte et al. (2008)	Institutional/university	NA	**Weighing:** vegetables were weighed before handling and after handling, clean and dirty leftovers. **Calculation:** index of clean leftovers and the index of rest-intake.	October and November 2005
Brazil	Sabino et al. (2016)	Institutional/hospital	NA	**Weighing:** distributed meals and leftovers. **Calculation:** index of remains according to Castro and Queiroz (2007).	August and September 2014 (16 days)
United States	Sakaguchi et al. (2018)	Commercial/restaurants	General	**Questionnaire:** questions about restaurant management knowledge about food waste (waste management) and actions to reduce waste.	From February to March 2016
Brazil	Santos et al. (2012)	Commercial/a-la-carte restaurants	General	**Checklists:** requirements of ISO 22000 and 14001 regarding the food security system, management responsibility, resource management, planning and manufacturing of safe products, validation, verification and improvement of the food security system. By interviewing supervisors, employees and/or owners and direct observation. **Classification:** conformity according to Collegiate Board Resolution (RDC) nº 275/2004.	NA
Brazil	Silva et al. (2019)	Institutional/nongovernmental organization	Employees, companions and patients of the service	**Weighing:** meals produced, clean leftovers and discarded leftovers. **Calculation:** percentage of leftovers and rest-intake.	1st and 29th of July 2018 (21 days)

(Continued)

Table 1. (Continued)

Country	Author (year)	Type/location of institutions	Clientele	Forms of assessment of sustainability	Period of assessment
Finland	Silvennoinen et al. (2015)	Commercial/workplace canteen Institutional/school and childcare	Preschoolers, schoolchildren, workers, general public	**Weighing:** sources of food waste generation (kitchen waste, service waste and customer leftovers). Originally inedible waste was also analysed.	211 days
Finland	Silvennoinen et al. (2019)	Commercial/a-la-carte and self-service restaurants Institutional/university	Students and professionals	**Weighing:** waste of food and waste per customer.	482 days
Brazil	Soares et al. (2011)	Institutional/company	Operational staff	**Weighing:** leftover preparations and per capita calculation of clean leftovers and cost.	5 months
Wales	Sonnino and McWilliam (2011)	Institutional/hospital	Surgery and rehabilitation patients	**Questionnaire:** interviews with the main actors of the meal service (CPU Manager and the six main suppliers of the 25 ingredients). **Weighing:** rest-intake and leftovers.	Weekly study
Brazil	Souza et al. (2018)	Institutional/early childhood education centres	Children of both sexes, aged between 17 and 63 months	**Weighing:** ingredients, meals produced, distributed and leftovers. **Calculation:** rest-intake index.	Between March and July 2014 (15 days)
Brazil	Strasburg and Jahno (2017a)	Institutional/universities	University students, graduate students, teachers, civil servants and service providers	**Calculation:** eco efficiency, correction factor for each food, water footprint defined by Yu et al. (2010) Quantification of the total consumption of each food purchased in 2012 in each institution, verification of the caloric value (kcal) of each food, generation of correction factor residues (resulting from the calculation of the correction factor).	NA
Brazil	Viana and Ferreira (2017)	Institutional/school	Students and servers	**Weighing:** five samples of the food produced and leftovers. **Calculation:** percentage of leftovers and rest-intake index.	5 consecutive days
China	Wang et al. (2017)	Commercial/restaurants	NA	**Weighing:** Food and its containers. **Calculation:** food waste per capita per meal.	NA
Brazil	Zandonadi and Maurício (2012)	Mixed commercial restaurant (centralized meal for the self-service restaurant and decentralized meal for the meal transported)	Workers	**Weighing:** rest-intake and the clean leftover of the preparations.	12 days
Brazil	Zotesso et al. (2016)	Institutional/university	University students and staff	**Weighing:** food waste in the pre-preparation, preparation and post-consumption stages. **Calculation**: correction factor, percentage of leftovers.	From March to August 2012

NA: not available.

The aims, methods of data analysis and the main results of the studies included in this review are shown in Tables 2 and 3.

Most publications aimed at quantifying and evaluating solid waste, by weighing rest-intake and leftovers (Table 2). The articles also focused on research on sustainability actions, compliance with environmental management, strategies for preventing waste, satisfaction with the menu and cost of leftovers (Table 3).

Regarding data analysis, there was a predominance of descriptive statistics showing frequencies, means and standard deviations (41/44). We observed that, in studies that applied statistical tests, sustainability indicators were compared between types of menus (omnivorous and vegetarian), forms of distribution (set meals, buffet) and customer satisfaction (rest-intake and acceptance of the menu) (Tables 2 and 3).

Results from studies that evaluated solid waste (38/44) revealed high amounts of waste, in both institutional and commercial segments. Although a few studies (3/38) included inorganic waste, the measurement and production of organic waste was predominant. The meal processing/production stage was identified as the main source of waste (5/38). Other aspects that impacted waste indicators were the customers' dissatisfaction with the menu and portion sizes (Table 2).

The studies shown in Table 3 (7/44) revealed an absence of measures to assess sustainability in the production of meals (3/7), in addition to inadequate handling, disposal and/or separation of waste (3/7) and the lack of awareness of managers regarding this issue (1/7) (Table 3).

When evaluated the risk of bias of the studies, it was found that just one study (1/44) was classified as moderate risk; all other (43/44) was considered as low risk of bias. All studies presented the characterization of the institution and the specification of the sustainability measure, as the results of the studies answer its main questions. The limitations observed were the lack of representativeness of the institution and non-randomized selection (38/44); the data collected not described in detail (3/44); the sustainability measure is not valid and reliable way (6/44); and the statistical analyses was not appropriate (1/44) (Table 4).

Discussion

This systematic review established that the assessment of sustainability practices in the food service is carried out mostly through quantification and classification of solid waste. Most studies found unsatisfactory results through the sustainability indicators used, especially those involving quantification of waste, in addition to the lack or shortage of sustainable development measures.

The main reasons for waste in the meal production environment usually involve expired products, overproduction of food, and excess of rest-intake, according to Aamir et al. (2018). In addition, Zandonadi and Maurício (2012) point the dissatisfaction of consumers with the menu as a factor impacting the generation of food waste.

A similar observation was made by Ricarte et al. (2008), who evaluated food waste in a Brazilian university cafeteria in Fortaleza-CE, focusing on different forms of waste, both internal and external to production. These authors found that the low acceptance of some preparations and the lack of variety were the main responsible for dissatisfaction with the menu. In the 25 menus offered during the survey, rates of rest-intake classified as good ranged from 4.93% to 7.30%, while poor ratings were in the range of 7.69–9.65% and unacceptable ratings from 10.46% to 14.64%. There were no rates of rest-intake classified as optimal.

On the other hand, for Betz et al. (2015) the portioning of the foods was one of the causes of waste. Their study assessed two different companies in Switzerland, both served by the same catering company, company A in the education sector (producing around 450 meals a day) and company B in the business sector (meals for employees, more than 750 meals a day). The authors found that when the portion size was determined by the crew rather than the customers, rest-intake were significantly more frequent ($p < 0.00$). While answering a questionnaire, the customers cited 'too large' portions as the main reason for the remaining of plate waste. In view of this, the authors emphasized the importance of adapting portion sizes to the requirements of the customers.

Economic and structural issues that lead to the lack of variety on the menu, an insufficient number of professionals to prepare more elaborate menus, and lack of equipment are also behind high rates of leftovers, according to Moura et al. (2009). These authors conducted a study in the food service of a State Center for Professional Education, in Guarapuava, state of Paraná, Brazil, which serves an average of 280 meals for lunch daily. They found an average of 60.39 g of leftovers per capita, and that the dirty leftovers from this food service could feed 28 people daily.

This systematic review revealed that few studies evaluated the adoption of strategies against the waste of resources and on waste management by establishments. However, that is crucial for the dissemination of the concept of sustainability in the meal production sector (Strasburg and Jahno, 2017b).

Halmenschlager (2017) investigated food services in public and private hospitals in the southern region of the Rio Grande do Sul state in Brazil, using two instruments: an adapted questionnaire that addressed practices and projects on sustainability, and a checklist of good environmental practices in food services. Based on the percentage of adequacies assessed through the Checklist of Good Environmental Practices in Food Services, of the 14 hospitals studied only four had a higher percentage of adequacies than inadequacies, the highest percentage of adequacy having reached 66% and the smallest 24%. These instruments also generated results in relation to service managers, who were asked about actions taken by the food services in relation to meal production sustainability, and about practices confirming these actions. Only 36% reported having promoted sustainable measures, while 43% believed to have partly done so and 21% did not do it at all.

Among sustainable production practices that can be developed in food service, those aimed at reducing waste and optimizing the use of natural resources, especially water and energy, are worthy of note. It is indispensable to promote the continuous and

Table 2. Objectives, data analysis and main results of the studies included in the systematic literature review that involved the quantification of food waste.

Authors (year)	Objectives	Data analysis	Main results
Abdelaal et al. (2019)	To quantify and disaggregate, using a bottom-up approach, the food waste at a university campus in Qatar.	Descriptive (average and percentage)	**General food waste:** - Food waste: 4181 kg - Total food waste generation (three locations): 329.5 kg day^{-1} - Avoidable waste (fraction discarded because it is no longer desired or is no longer in its best state): 211.1 kg - Inevitable waste (fraction that arises from food during the preparation process and normally cannot be consumed as egg shells, fruit shells and coffee grounds): 118.4 kg day^{-1}.
Abreu et al. (2012)	To evaluate food waste in the production and distribution sectors of a nutrition and dietetics institution of a hospital located in São Paulo (SP), Brazil.	Descriptive (average and percentage)	**General food waste:** - Clean leftovers: From 7.2% to 17.2%, with the average of 11.6% - Rest-intake by person: From 34.0 g to 123.0 g, with the average of 72.0 g.
Alves and Ueno (2015)	To identify and quantify organic and recyclable solid waste generated in the production and distribution of meals in a food and nutrition institution and propose actions related to the reduction of solid waste generation and its destination to sanitary landfills.	Descriptive (average and percentage)	**General food waste, stage and types of solid waste:** - Of 2740 meals, 486.6 kg of solid waste were generated, resulting in an average per capita of 0.177 kg day^{-1} of waste. - The waste was distributed as follows: 58.0% in food processing, 31.9% in returns and 10.1% in stock and storage. - Types of solid waste: 85% was organic compounds of unwanted portions of vegetables and meat, food scraps, leftovers from dinners, expired food and food samples, and 15% was composed of waste paper/cardboard, plastics and cans.
Aranha and Gustavo (2018)	Check and analyse food waste based on the indexes of clean and dirty leftovers and rest-intake of a food and nutrition institution in the city of Botucatu (SP), Brazil.	Descriptive (percentage)	**General food waste:** - Average dirty leftover (%): 19.15 - Clean leftover (%): 3.46 - Rest-intake (%): 8.73.
Araújo and Carvalho (2015)	To evaluate the meals production process in a food and nutrition unit in Goiania (GO), Brazil, focusing on waste generation and sustainable aspects.	Descriptive (average and percentage)	**Food waste by type and stages:** - Solid waste: 776 kg, of which: - 568.38 kg of organic compounds - 207.62 kg of inorganic compounds - 17.65 kg of oil - Stage of organic waste generation: 1° is production (55.2%) e 2° is distribution (38.98%) - Stage of inorganic waste generation: 1° is reception (36.95%) and 2° is distribution (35.9%).
Beal et al. (2018)	To quantify and analyse the remaining intake of meals served to the sick community and the rest-intake and dirty leftovers from the healthy community of a hospital food and nutrition institution located in a municipality in the Southwest of Paraná, Brazil.	Descriptive (average and percentage)	**Waste according to the public:** - Healthy community: - Average of total leftovers: 44.71 kg (44.19%) - Average of the rest-intake index: 8.72% - Sick community: Average of rest-total intake of the pots served: 19.02 kg (28.36%).
Betz et al. (2015)	To provide general information about food loss in the food service industry and to assess the level of waste, the reasons for its accumulation, its composition (by food type), and its point of origin in two food service companies in Switzerland. Reasons behind food waste were deduced, and strategies for its reduction were developed.	Analytical and descriptive (percentage)	**General food waste and motivation:** - % of clients produced rest-intake: Institution A (education sector): 15.79% ($n = 356$) of clients and Institution B (business sector): 18.32% ($n = 382$) of clients. - Rest-intake by portioning: more common when portion served by staff ($p < 0.001$) - Main causes of rest-intake according to clients: portion size. - Institution A (university): 202.066 kg, of which more than 60% were food waste: 25% were rest-intake, 10% waste of preparation process and 0.84% waste from storage. - Institution B (*catering* by employees): 321.634 kg foods, of which 38.21% were food waste, of which 32.35% from preparation process. - Approximately 25% of food waste in both institutions were considering avoidable (expired food, improper storage conditions and inadequate portioning). - Small portion of the food waste (Institution A: 1.41% and Institution B: 1.44%) was unavoidable (parts of food that are unfit for consumption such as bones, skins and husks, especially in the preparation stage) **Consumer satisfaction** - Institution A: 57.1% ($n = 359$) and Institution B: 71.73% ($n = 382$) - Satisfied customers produced food waste less often than dissatisfied ones ($p = 0.01$).
Canonico et al. (2014)	To evaluate the index of rest-intake and leftovers of a popular restaurant in the city of Maringá (PR), Brazil.	Descriptive (average and percentage)	**General food waste:** - Clean leftovers average: 332.58 kg day^{-1} and the quantities by person ranging from 3.35 g to 16.3 g. - Clean leftovers average (% related to distributed meal): 80.67 ranging from 8.86 to 25.6 by day - Rest-intake average (%): 9.49 ranging from 7.48 to 14.49.

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Table 2. (Continued)

Authors (year)	Objectives	Data analysis	Main results
Carvalho et al. (2013)	To analyse the data regarding the occurrence of waste, in the form of leftovers and rest-intake in a meal producer institution of a furniture company in the city of Uba (MG), Brazil, in order to diagnose the level of waste.	Descriptive (average and percentage)	**General food waste:** - Rest-intake by person (kg): From 0.047 to 0.093, with average of 0.068 - Rest-intake average (%): 6.87.
Copatti et al. (2018)	To evaluate the rest-intake index of patients and companions of a hospital food and nutrition institution from the analysis of leftovers present in trays returned for cleaning.	Descriptive (average and percentage)	**General food waste:** - Average rest-intake: 20.80%.
Dias-Ferreira | et al. (2015)	To quantify the overall amounts of plate waste arising from the meal delivery service at hospital; find out what is being offered to patients and which items are returned as waste; and, highlight the environmental cost to society and possible cost savings for the hospital food service budget.	Descriptive	**General food waste and by preparation:** - Total: From 0.462 to 1395 kg patient^{-1} day^{-1} in Ward with a similar distribution between lunch and dinner. - Food waste by patient: Average of 953 g food by day, representing 35% of served foods. - Food waste by preparation: More than 50% of bread and main course; 12% of soup e 10% of dessert/fruit.
Domingues et al. (2016)	To quantify the organic solid waste generated in a university cafeteria in the city of São Paulo (SP), Brazil.	Descriptive (average ± standard deviation)	**General food waste:** - Rest-intake (kg): 914, with average ± sd of 29.5 ± 5 and value by person of 60.8 ± 9.4 g - Rest-intake average by person ranged from 44.2 g to 79.1 g, with average of 60.8 g - Dirty leftovers (kg): 937.5, with average ± sd of 30.2 ± 14.3 value by person of 63.3 ± 32.3 g - Total solid waste: 1851.5 kg.
Engström and Carlsson-Kanyama (2004)	Facing the challenge of old data about food losses, while recognizing the need to provide updated information and analyses of loss fractions and prevention strategies.	Descriptive (average and percentage)	**Total food losses and by stage** - Total: 20% of the food delivered to the food service institutions was lost, in which rest-intake constituted half of the recorded losses. - Losses related to the handling of the food: 4% (storage and preparation), 6% leftovers e 10% rest-intake. Strategies to reduce losses - All the participating institutions were concerned with reducing losses during the handling of food. - Strategies: stock control (older foods first) and take care of leftovers so they can be served again or used in other preparations.
Eriksson et al. (2017)	To quantify food waste in schools, preschools and elderly care homes for the specific case of one municipality in Sweden; to analyse the material for hotspots that could be targeted by waste reduction measures; and, to evaluate whether food waste was greater when the food was prepared farther away from the consumers.	Descriptive (average)	**General food waste:** - Food waste: 23% of the food served - Total waste: 64% corresponded to leftovers, 33% from rest-intake and 3% from others.
Fatel et al. (2018)	To evaluate the rest-intake index and total leftovers from lunch served in the cafeteria of a hospital food and nutrition institution, located in western Paraná, Brazil.	Descriptive (average ± standard deviation)	**General food waste:** - Overall average of clean leftover (kg): 3.21 ± 1.72 - Overall average of dirty leftover (kg): 15.61 ± 1.56 - Overall average of total leftovers (kg): 18.82 ± 1.55 - Overall average of total leftovers (%): 7.97 ± 0.84 - Overall average of remains (kg): 12.62 ± 0.40 - Overall average of rest-intake index (%): 5.93 ± 0.18 - Overall average of unused food (%): 12.12 ± 1.52.
Ferreira et al. (2012)	To assess the per capita, clean leftovers and rest-intake of children of both sexes aged between 6 months and 5 years old at an early childhood education centre.	Descriptive (percentage)	**General food waste:** - Rest-intake (%): 26/09/2011: 15.62; 28/09/2011: 15.51; 29/09/2011:14.49; 30/09/2011: 14.40. - Rest-intake by children (kg): 26/09/2011: 0.101; 28/09/2011: 0.107; 29/09/2011: 0.108; 30/09/2011: 0.096. - Clean leftovers (%): 26/09/2011: 7.71; 28/09/2011: 15.07; 29/09/2011: 20.62; 30/09/2011: 9.08. - Clean leftovers by children (kg): 26/09/2011: 0.050; 28/09/2011: 0.104; 29/09/2011: 0.154; 30/09/2011: 0.061.
Galian et al. (2016)	To quantify food waste in a medium-sized industrial restaurant in the city of Maringá (PR), Brazil.	Descriptive (average and percentage)	**General food waste:** - Average rest-intake: 4.41 ± 1.4 kg and 4.19 ± 1.2% - Clean leftovers: 15.92%.
Issa et al. (2014)	To evaluate the planning, production process, distribution and adequacy of the nutritional intake of the main meal menu offered in integrated public educational institutions in Belo Horizonte (MG), Brazil.	Descriptive (average, minimum and maximum)	**General food waste:** - Rest-intake (%): 4.90 (from 0.23 to 22.70) - Clean leftovers (%): 7.06 (from 0.00 to 38.81) - Dirty leftover (%): 5.30 (from 0.00 to 35.97).

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Table 2. (Continued)

Authors (year)	Objectives	Data analysis	Main results
Juffo et al. (2016)	To evaluate the volume of organic solid waste generated in different food services and the quality of the segregation process of this waste for reuse in animal feed.	Analytical (Chi-square and Spermann correlation) and Descriptive	**Food waste by service:** - Ready-to-eat: From 0.9 kg to 36 kg - Buffet: From 2.6 kg to 45.9 kg - Snacks: From 4.9 kg to 53.3 kg - All-you-can-eat: From 3.9 kg to 31.7 kg - Buffet, generated a greater volume of waste (43.43 kg), even with a lower volume of daily meals (775 clients). - Ready-to-eat service generated less waste (19.91 kg), with 2140 clients daily.
Mello et al. (2011)	To evaluate food waste in a food and nutrition institution located in a club in the city of Rio de Janeiro (RJ), Brazil.	Descriptive (average ± standard deviation)	**Food waste by meal** - Lunch: Rest-intake (kg): 8.2 (1.98) Rest-intake index (%): 8.42 (2.50) Rest-intake by person (g): 70.8 (20.03) - Dinner: Rest-intake (kg): 4.7 (1.2) Rest-intake index (%): 13 (4.5) Rest-intake by person (g): 100 (29.8).
Moura et al. (2009)	Know and disseminate institution's waste indexes, as well as to provide for their reduction in the future through campaigns with customers and training with handlers.	Descriptive (average ± standard deviation)	**General food waste:** - Rest-intake (kg): 15.36 (5.3) - Rest-intake (%): 11.17 (2.64) - Rest-intake by person (g): 58.44 (19.86) - Clean leftovers (kg): 15.85 (5.72) - Average percentage of clean leftovers (%): 10.41 (3.48) - Total food waste (kg): 31.21 (8.57) - Food waste by person (g): 118.68 (32.69).
Nonino-Borges et al. (2006)	Was to assess food wastage in the Hospital Emergency Section of the Clinical Hospital of the School of Medicine of Ribeirão Preto, University of São Paulo, Brazil and to propose a strategy to face this problem.	Descriptive (average and percentage)	**General food waste** - Considering a total of 650 meals, totalling 402 kg of food (Lunch: 220 kg and Dinner: 182 kg). 123 kg (31%) returned to the food service, which 58 kg for lunch (27%) and 65 kg for dinner (35%) were considered rest-intake. - Disregarding the returned-intact meals, 353 kg of food were offered (Lunch: 202 kg and Dinner: 151 kg). Rest-intake found was 77 kg, which 40 kg (20%) for lunch and 37 kg (25%) for dinner. Lunch and Dinner = 571 meals Total rest-intake (kg): 77.0 Per capita rest-intake (kg): 0.15 ± 0.04 Rest-intake (%): 24.0 ± 70.0.
Painter et al. (2016)	To estimate food waste quantities generated in university dining hall facilities as a basis for identifying potential areas for promoting food waste reduction.	Descriptive (average and percentage)	**General food waste:** - Total food waste (g) by student daily: 2775 - Total measured amount of food waste over the sampling period: 10 tons. - Waste average (g) aluno/dia: 555 - Total food waste (kg): 10,481.
Papargyropoulou et al. (2019)	To determine the patterns and causes of food waste generation in the hospitality and food service sector, in order to identify the most promising measures for food waste prevention.	Descriptive (average and percentage)	**General food waste:** - Average waste for each meal/customer served (kg): 0.53 (0.08–1.68) - Waste of preparation (overproduction, processing, expired foods, spoiled foods) (%): 15–55 - Leftovers (%): 22–50 - Rest-intake (%): 23–35 - Avoidable waste: 32–63% of total waste.

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Table 2. (Continued)

Authors (year)	Objectives	Data analysis	Main results
Ricarte et al. (2008)	To evaluate food waste in a university restaurant, in Fortaleza (CE), Brazil, focusing on the different forms of waste, internal and external to production, observing the conditions of storage, conservation and pre-preparation of vegetables and fruits; the procedures for using clean leftovers; and the index of rest ingestion of meals, aiming at diagnosing the level of waste of the institution.	Descriptive (average) Food waste was evaluated by menus and was classified according to Aragão (2005) Excellent: from 0% to 3.0%; Good: from 3.1% to 7.5%; Bad: from 7.6% to 10%; Unacceptable: above 10%	**- Food waste by foods and stage:** Fruits and horticultural: 203 kg had been lost in the storage (5.84%) e pre-preparation (25.76%), corresponding to 31.60% food waste. Leftovers: Salads (5 kg day^{-1}, representing 7% of the produced food), without reuse. Average Leftovers (%): 9.87 Average Rest-intake (%): 8.39 **- Food waste by menu:** Rest-intake: Of the 25 menus offered during this survey, 12 (48%) resulted in poor rest-intake; 9 (36%), values classified as good and 4 (16%) showed unacceptable values.
Sabino et al. (2016)	To evaluate the rest-intake index of a food and nutrition institution that produces meals transported to a hospital in Teófilo Otoni (MG), Brazil.	Descriptive (average ± standard deviation)	**General food waste:** - Rest-intake (%): ranged from 22.73 to 47.87, with average of 39.62 - Rest-intake by person (g): 173.
Silva et al. (2013)	To make a qualitative assessment of the nutritional and sensory aspects of day-care centre menu preparations and quantify the rest-intake of children that attend public day-care centres in the municipality of São Paulo (SP), Brazil.	Descriptive (percentage)	**General food waste:** - Rest-intake average (%): 34.0 from 25.0 to 43.0.
Silva et al. (2019)	To assess the index of leftovers and rest-intake from the lunch at the Food and Nutrition Unit of the Support Group for Oncology Patients.	Descriptive (average)	**General food waste:** - Total leftovers (%): 24.4 - Average leftovers per customer (g): 0.164 - Daily average rest-intake for patients (kg): 2.776 - Daily average rest-intake for companions and employees (kg): 3.527 - Average rest-intake among patients (%): 6.75 - Average rest-intake among companions and employees (%): 8.29.
Silvennoinen et al. (2015)	To estimate the volume of originally edible food waste and its distribution among different food service outlets; to monitor the sources of food waste generation e.g. kitchen, service and customer leftovers; to analyse the content of the plate leftovers; and to monitor originally inedible bio waste.	Descriptive (percentage, average, minimum, maximum)	**General food waste:** - Of 23,220 kg of food prepared during the study period, 4396 kg were wasted. - The amount of food waste of edible origin (spoiled products, improperly prepared food, expired date products, overproduction, overproduction), in relation to prepared foods ranged from 19% to 27%, according to the type of establishment - The inedible waste (vegetable peelings and bones) representing from 2% to 11% of all the food handled in the outlets. - The main drivers of wasted food are buffet services and overproduction (clean leftovers).
Silvennoinen et al. (2019)	To explore food waste data, its variation and measurement method and discuss what kind of monitoring process would be optimal for Finnish food service system; to get up-to-date information about food waste amounts in the sector and acquire new knowledge about origins of it, the composition of serving waste; and, to get a sense of the diversity within the sector.	Descriptive (average and percentage)	**General food waste:** - Food destination: 17.5% goes to waste - Amount of waste: from 449 g of prepared food per serving, 78 g was wasted - Origin of waste: 1st leftovers (11.4%), 2nd remains (3.9%) and 3rd preparation waste (2.2%).
Soares et al. (2011)	Quantify and evaluate the cost of clean leftovers in eight food and nutrition institutions of a large steel company.	Descriptive (percentage)	**General food waste and costs:** - 50% of the food service establishment did not reach values less than or equal to 30 g of clean leftovers. - Clean leftovers by person: between 24 g and 60 g, equivalent to a monthly food waste of 176–1213 kg of food. - Monthly cost of food waste: From 2.2% to 3.0% of the amount spent monthly on food.
Sonnino and McWilliam (2011)	Address the need for more comprehensive studies of sustainable food systems through a case study of hospital food waste in Wales, UK.	Descriptive (average and percentage)	**General food waste by meal service:** - Total food waste (%): From 19.0 to 66.0, varying between hospitals and between bulk and plated service - Rest-intake (%): From 14.0 to 42.0.
Souza et al. (2018)	To evaluate the nutritional adequacy of meals served and consumed, as well as quantifying food waste in child day-care centres in Maceió (AL), Brazil.	Descriptive (average and percentage)	**Waste according to menu:** - 85 foods and preparations on the menu: 68% with a percentage of leftover intake >10% - Food actually consumed by children: ranged from 79% to 84% of the food served.

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Table 2. (Continued)

Authors (year)	Objectives	Data analysis	Main results
Viana and Ferreira (2017)	To evaluate food waste in a food and nutrition institution in the city of Januária (MG), Brazil, focusing on rest-intake.	Descriptive (average and percentage)	**General food waste:** - Clean leftover (%): ranged from 0.08 to 27.44 - Rest-intake (%): ranged from 5.48 to 18.5 - Average rest-intake (kg): 37.32 -Average rest-intake per person (g): 79.
Wang et al. (2017)	To characterize the total and per capita food waste generated in Chinese resultants and their composition based on field survey and direct weighing in the four case cities; and, to explore the patterns of and reasons behind restaurant food waste generation in China and their implications on food waste reduction strategies.	Descriptive (average)	**General food waste:** Average amount of food waste per capita per meal in the four cities (g): 93 Average per capita waste per meal according to city: - Chengdu 103 g - Lhasa 98 g - Shanghai 97 g - Beijing 77 g.
Zandonadi and Maurício (2012)	To evaluate the consumer profile regarding the food waste and menu acceptability of the civil construction work force in one institution of Cuiaba (MT), Brazil.	Analytical and Descriptive (average and percentage)	**General food waste:** - Institution A: Average of 24.18 kg foods (leftovers and rest-intake) by person. Leftovers: From 4.02% to 33.61%, with the average of 17.35% Rest-intake: From 2.2% to 8.2%, with the average of 5.16%. - Institution B: Average of 16.56 kg foods leftovers and rest-intake) by person Leftovers: From 1.32% to 11.37%, with the average of 5.37% Rest-intake: From 1.88% to 7.2% with the average of 3.63%.
Zotesso et al. (2016)	To evaluate food waste in the university restaurant of the State University of Maringá (PR), Brazil, in order to identify the factors that most contribute to waste in the institution and propose actions to reduce it.	Descriptive (average and percentage)	**Food waste according to month of evaluation:** - Leftovers average (%): 13.3% (March) and 16.4% (August). - Rest-intake average (%):11.9% (2.4) in march and 10.4% (2.7) in august. - Leftovers (kg): 192.5 (84.6) in march and 209.6 (105.6) in august. - Rest-intake (kg): 166.3 (60.6) in march and 116.6 (48.8) in august.

Table 3. Objectives, form of data analysis and main results of the studies included in the systematic literature review that involved the application of questionnaires, checklists and water footprint assessment.

Author (year)	Objective of the study	Data analysis form	Main results
Aamir et al. (2018)	Quantify the amount of food waste in the restaurant industry and explore the underlying reasons for this.	Descriptive (average)	**General waste:** - Average amount of waste per day (kg): 35.6 **Ways to avoid waste:** - Demand forecasts and team training were reported by most respondents **Waste-generating sources:** - Overproduction, rest-intake and expired food in all evaluated restaurants **Barriers:** - Just a separate food waste bin as the main source of separation of food waste in most restaurants - Responsibility concerns as the main barrier to food donation in all restaurants - Most restaurants preferred to donate food to nursing homes and orphanages, followed by nongovernmental organizations and slums, and finally schools **Practices to reduce the generation of solid waste:** - 64.29% of hospital institutions do not use the Technical Preparation Form - 78.57% do not control losses in the pre-preparation - 71.43% do not control leftovers - 78.57% do not check remains.
Halmenschlager (2017)	Diagnose the situation of environmental sustainability management in the production of meals from hospital food services, located in the southern region of the state of Rio Grande do Sul, Brazil.	Descriptive (percentage)	**Measures related to the rational use of water:** - 100% ($n = 14$) of hospitals perform identification and correction of leaks and present fat boxes in an appropriate state of conservation, functioning and location - 92.86% use an adequate amount of detergent - 85.71% perform controlled rinsing in the hygiene process **Measures related to the rational use of energy:** - All participating hospitals adopt some measure to reduce energy, the main ones being the exclusive use of fluorescent lamps, natural ventilation and air conditioning system in areas where there is no natural ventilation. - 100% perform maintenance of their equipment and heating and cooling systems, all of which are corrective, predictive and preventive maintenance occurs in less than 1/3 of the sample **Sustainability practices adopted:** - 79% of UANs perform selective collection - 57% separate cans, plastics, paper, metal and organic waste - 43% separate only recyclable solid waste from organic waste - 93% promote training for the handling of solid waste - 71% promote training for rational use of water and prevention of waste during hygiene - 78% promote training for the rational use of energy **Interview with managers:** - The managers interviewed ($n = 14$) were asked about what sustainability is and 71% ($n = 10$) demonstrated knowledge about the topic, while 29% ($n = 4$) did not know and/or did not want to answer - Regarding the relationship between sustainability and the environment, 64% ($n = 9$) showed understanding on the subject, 21% ($n = 3$) answered partially and 14% ($n = 2$) did not know or did not want to answer the question - When asked about the impact the institution has on the environment, 57% ($n = 8$) answered in order to demonstrate knowledge about the subject, 7% ($n = 1$) answered in part and 36% ($n = 5$) did not knew or did not want to answer - When asked about the institution's actions in relation to sustainability in the production of meals and what practices demonstrate these actions, 36% say they have sustainable actions, 43% believe they have part actions and 21% have no sustainable actions.
Hatjiathanassiadou et al. (2019)	To evaluate the environmental impacts through water footprint estimation of conventional and vegetarian menus; and identification of the place of origin of foodstuff used in meals served in a university restaurant of a federal public university in Brazil.	Analytical (*T* Test) Descriptive (percentage, average per capita, standard deviation)	**Water footprint:** - Traditional menus: 2752.0 + 396.8 L per capita per week - Vegetarian menu: 1113.9 + 125.8 per capita per week, with $p < 0.05$ - Water footprint 2.47 times higher in the traditional menu, associated with the use of products of animal origin, mainly beef **Disposal of raw materials:** - 75% ($n = 12$) post production, 19% ($n = 3$) pre-prepared and 6.2% ($n = 1$) storage **Use of food:** - 62.5% ($n = 10$) make the most of raw materials - 25.0% ($n = 4$) reuse some foods in other dishes - 37.5% ($n = 6$) discard leftovers entirely - 18.8% ($n = 3$) make leftovers available for employees' meals and preparation of pies - 12.5% ($n = 2$) donate to homeless people - 6.2% ($n = 1$) leftovers are collected from the oil by an outsourced company.

(Continued)

Table 3. (Continued)

Author (year)	Objective of the study	Data analysis form	Main results
Pospischek et al. (2014)	Evaluate the environmental sustainability actions developed in commercial restaurants located in the city of São Paulo.	Descriptive (percentage)	**Concern for the environment:** - 37.5% ($n = 6$) had no concern or action against the degradation of the environment - 62.5% ($n = 10$) claimed to be concerned with the degradation of the environment - 31.2% ($n = 5$) the action taken for this purpose consisted of separating recyclable waste - 18.8% ($n = 3$) in the correct disposal of frying oil - 12.5% ($n = 2$) reported that their concern with the environment was focused on the product used to prepare the barbecue included in the self service **Selective collect:** - 87.5% ($n = 14$) measured the amount of waste generated per day, of these, 18.7% ($n = 3$) had containers in their establishments with different colours for each type of waste **Origin of waste:** 1st organic waste; 2nd cardboard; 3rd plastic; 4th metals; 5th glass/porcelain **Disposal of organic waste:** - 100% ($n = 16$) of food waste goes to waste, not using crushers connected to the sewer - 6.2% ($n = 1$) separated organic waste to produce fertilizer **Oil destination:** - 100% ($n = 16$) stored in containers and later collected by an outsourced company - 56.2% ($n = 9$) the outsourced company that collects the oil leaves cleaning products such as soap, bleach and detergent in exchange.
Sakaguchi et al. (2018)	To investigate how restaurateurs in Berkeley, California, USA perceive food waste given current financial incentives and policies.	Descriptive (average)	**Actions in relation to food waste:** - 34% did not measure the amount of food waste they produced - 72% donated edible leftovers to employees as a way to avoid waste - 38% asked customers to take leftovers home to feed the animals - 86% of restaurants did not donate edible leftovers - 14% disposed of the garbage in landfills - 75% of the establishments evaluated had uncertainties about their responsibility, which was an impediment to donating excess food - 79% did not collaborate with charities to donate surplus food - 69% said they were not eligible to present a tax benefit or did not know details about the subject.
Santos et al. (2012)	To use two checklists based on the ISO 22000 and 14001 standards to assess conformity of a-la-carte restaurants in Brasilia with the Food Safety Management System and Environmental Management System.	Descriptive (percentage) Group 1 (G1): compliance with 76 to 100% of the items in the checklists; Compliance of group 2 (G2) with 51 to 75%; Compliance with group 3 (G3) with 0 to 50%.	**Compliance with ISO 22000 items:** - Food security system: G1 (2.7%) restaurants; G2 (10.8%) restaurants; G3 (86.5%) restaurants - Responsibility of management: G2 (13.5%) restaurants; G3 (86.5%) restaurants - Resource management: G2 (18.9%) restaurants; G3 (81.1%) restaurants - Plan and manufacture safe products: G3 (100%) restaurants - Validation, verification and improvement of the food security system: G3 (100%) restaurants **Compliance with ISO 14001 items:** - All restaurants were classified as G3 in relation to all sections of the standard - Direct observation revealed that the restaurants had no environmental concerns or compliance with Brazilian law that determines the separation of recyclable and disposable waste - Only 11 restaurants (29.7%) had a system for separating recyclable and nonrecyclable materials and proper disposal of cooking oil.
Strasburg and Jahno (2017a)	To propose and apply a procedure for evaluating environmental performance from the perspective of eco-efficiency, for the food service industry.	Descriptive	- The first equation evaluated the relationship between the energy supply and the total amount of raw materials with respect to the environmental impact. The higher this value, the better the relationship. The restaurant ranking showed No. 5 as the most eco-efficient (1071), followed by restaurants 3 (0.940), 1 (0.721), 2 (0.693) and 4 (0.283) - A reversal of the equation is made to assess the environmental impact on the relationship between energy supply and cost. The lower the value, the lower the environmental impact. The first two positions were for restaurants 5 (3103) and 3 (3824), followed by 2 (4758), 1 (5135) and 4 (10,959).

Table 4. Risk of bias assessment of the studies included in the systematic review according to MAStARI.

Author (year)	Risk percentage	Risk of bias
Aamir et al. (2018)	57.14	Moderate
Abdelaal et al. (2019)	85.71	Low
Abreu et al. (2012)	85.71	Low
Alves and Ueno (2015)	85.71	Low
Aranha and Gustavo (2018)	85.71	Low
Araújo and Carvalho (2015)	71.43	Low
Beal et al. (2018)	85.71	Low
Betz et al. (2015)	85.71	Low
Nonino-Borges et al. (2006)	85.71	Low
Canonico et al. (2014)	85.71	Low
Carvalho et al. (2013)	85.71	Low
Copatti et al. (2018)	85.71	Low
Dias-Ferreira et al. (2015)	85.71	Low
Domingues et al. (2016)	85.71	Low
Engström and Carlsson-Kanyama (2004)	85.71	Low
Eriksson et al. (2017)	100.00	Low
Fatel et al. (2018)	85.71	Low
Ferreira et al. (2012)	85.71	Low
Galian et al. (2016)	85.71	Low
Halmenschlager (2017)	100.00	Low
Hatjiathanassiadou et al. (2019)	85.71	Low
Issa et al. (2014)	100.00	Low
Juffo et al. (2016)	71.43	Low
Longo-Silva et al. (2013)	100.00	Low
Mello et al. (2011)	85.71	Low
Moura et al. (2009)	85.71	Low
Painter et al. (2016)	85.71	Low
Papargyropoulou et al. (2019)	71.43	Low
Pospischek et al. (2014)	85.71	Low
Ricarte et al. (2008)	71.43	Low
Sabino et al. (2016)	85.71	Low
Sakaguchi et al. (2018)	71.43	Low
Santos et al. (2012)	85.71	Low
Silva et al. (2019)	85.71	Low
Silvennoinen et al. (2015)	85.71	Low
Silvennoinen et al. (2019)	71.43	Low
Soares et al. (2011)	85.71	Low
Sonnino and McWilliam (2011)	85.71	Low
Souza et al. (2018)	85.71	Low
Strasburg and Jahno (2017a)	85.71	Low
Viana and Ferreira (2017)	85.71	Low
Wang et al. (2017)	100.00	Low
Zandonadi and Maurício (2012)	71.43	Low
Zotesso et al. (2016)	85.71	Low

MAStARI: Meta-analysis of Statistics Assessment and Review Instrument

permanent training of employees, along with the planning of menus considering seasonality and regional foods, as well as the adoption of appropriate processing techniques that preserve nutritional and sensory properties of food and its use in full (Abreu et al., 2012). The preventive maintenance of equipment, waste separation and adequate waste management are also important (Dias and Oliveira, 2016).

During the production and distribution of meals, one must consider the number of customers, so that the volume of meals produced is proportional to the demand, as well as the presentation and organoleptic aspects of the preparations, not to mention the adaptation to the climate. Adequate planning prevents high generation of leftovers and minimizes the environmental impacts caused by food waste, besides influencing the food services expenditure (Silvério and Oltramari, 2014; Soares et al., 2011).

The technical cards are valuable tools that can assist in controlling the waste of food service. These cards aid the nutritionist, standardizing and controlling production and distribution, directly influencing the quality of the service offered, in addition to facilitating the execution of the processes, the acquisition and control of products, and the planning of the menu. The sheets also provide data on correction and cooking factors per capita, portioning and nutritional information, contributing to the training of the crew (Akutsu et al., 2005).

Educational actions directed at the customers are also extremely relevant in promoting sustainability, in view of the direct impact of customer behaviour on food waste (Issa et al., 2014; Silvério and Oltramari, 2014). In the study by Painter et al. (2016), conducted in cafeterias at the University of Rhodes, South Africa, the average food waste was around 555 ± 107 g per student per day. The total amount of food waste measured over the sampling period was estimated to be around 10 ton. In addition, the students answered a questionnaire that provided an insight into their eating habits, and perceptions on the reasons behind food waste. When asked whether or not they finished the food on their plates, only 18% of students said they 'always' finished everything. Almost half of the students (46%) said they 'sometimes' finished their meals, 30% rarely did it, and 6% never finished their food, suggesting that a considerable proportion of students did not eat all of the food served. When students were asked why they did not finish their meals, the main reason was 'not liking the food' (73%). Other reasons were haste (32%), and 'just not being hungry' (30%).

Britto and Oliveiro (2017) described positive impacts on the control of rest-intake when promoting nutrition education against waste and changes in portion sizes in the nutrition and dietary service of a hospital in São José do Rio Preto, São Paulo. The authors observed that the average food waste decreased from 23 kg to 16 kg per day, a drop of 31% in the volume of waste. There was a monthly reduction from 680 kg to 477 kg of food waste, corresponding to 30% in total volume.

Borges et al. (2019) have also described a positive outcome after developing educational actions for employees and raising customer awareness in a university cafeteria. Clean leftovers dropped from 31.64 ± 10.80 kg to 14.93 ± 10.43 kg ($p = 0.001$), validating the effectiveness of the crew's training. The work with the customers, which was assessed through the analysis of rest-intake, also yielded positive results, with scraps dropping from 46.90 g to 37.83 g ($p = 0.021$). With the maximum value of acceptable waste in terms of rest-intake set at 10%, the authors reported a reduction from 8.68% to 6.20% of rest-intake after

implementation of the actions proposed ($p=0.003$), placing the cafeteria in a satisfactory range.

Ricarte et al. (2008) observed that the lack of measures to take advantage of clean leftovers resulted in approximately 7% of waste. Although an alternative to reduce food waste would be the donation of surpluses, some studies included in this review reported that a reason for this measure not being applied was the concern with the responsibility for any problems that may arise from the donated food (Aamir et al., 2018; Sakaguchi et al., 2018).

In addition to environmental, economic and social benefits, sustainability practices in the food service can be good for the consumers' health. The use of fresh foods in full and the respect for seasonality and local socio-biodiversity contribute to improving the quality of the food offered to the population (Veiros and Proença, 2010).

In this scenario, the important role of the nutritionist is emphasized, for this professional is trained to select effective methods of acquisition, production and distribution of food, as well as to supervise and analyse the indicators, aiming at better results along with the crew (Araújo and Carvalho, 2015).

It should be noted that most of the articles included in this study have been published in the last 5 years, and that all countries involved are members of the United Nations (UN). That may be related to the update of the 2030 Agenda for Sustainable Development that took place in 2015, built on the legacy of the Millennium Development Goals with the aim of boosting sustainability, eradicating inequalities and promoting the well-being of humanity. The UN established practices to be adopted by its allied countries, comprising 17 items termed SDGs that encompass zero hunger and sustainable agriculture, sustainable cities and communities, and responsible consumption and production (ONU, 2015).

This systematic review presents as its own limitations those of the selected studies, such as poor methodological detailing, specific and local investigations, and also a predominantly descriptive analysis of the results. Nevertheless, this is a pioneering study that included articles published in different databases, including grey literature, without restrictions on language and date of publication.

Conclusions

This review identified a restricted assessment of sustainability in food service, as opposed to the need of deepening sustainability indicators and the effect of meal production processes on sustainable development. High levels of waste, combined with the scarcity of practices aimed at controlling the use of natural resources and waste generation, and the recent debate on the subject, point to the importance of sensitizing professionals to the combination of different measures in this investigation, in addition to strategies to mitigate the environmental impact and the commitment of resources for future generations.

Author contributions

FCC and DAS had the idea for the article. FCC and LOF performed the literature search and data analysis. All authors drafted and critically revised the work.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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References

Aamir M, Ahmad H, Javaid Q, et al. (2018) Waste not, want not: A case study on food waste in restaurants of Lahore, Pakistan. *Journal of Food Products Marketing* 24: 591–610.

Abdelaal AH, Mckay G and Mackey HR (2019) Food waste from a university campus in the Middle East: Drivers, composition, and resource recovery potential. *Waste Management* 98: 14–20.

Abreu ES and Spinelli MGN (2003) Avaliação da Produção. In: Abreu ES, Spinelli MGN and Zanardi AMP (eds) *Gestão de Unidades de Alimentação e Nutrição: um modo de fazer*. São Paulo: Editora Metha, pp. 127–141.

Abreu ES, Simony RF, Silveira Dias DH, et al. (2012) Avaliação do desperdício alimentar na produção e distribuição de refeições de um hospital de São Paulo. *Revista Simbio-Logias* 5: 42–50.

Akutsu RC, Botelho RBA, Camargo E, et al. (2005) A ficha técnica de preparação como instrumento de qualidade na produção de refeições. *Revista de Nutrição* 18: 277–279.

Alves MG and Ueno M (2015) Identificação de fontes de geração de resíduos sólidos em uma unidade de alimentação e nutrição. *Revista Ambiente & Água* 10: 874–888.

Aragão MFJ (2005) *Controle da aceitação de refeições em uma Unidade de Alimentação Institucional da cidade de Fortaleza-CE. 78 f. Monografia* (Especialização em Gestão de Qualidade em Serviços de Alimentação) - Universidade Estadual do Ceará, Fortaleza.

Aranha F and Gustavo AFS (2018) Avaliação do desperdício de alimentos em uma unidade de alimentação e nutrição na cidade de Botucatu, SP [Evaluation of food waste in a food and nutrition unit in the city of Botucatu, SP]. *Revista Higiene Alimentar* 32: 28–32.

Araújo ELM and Carvalho ACMS (2015) Sustentabilidade e geração de resíduos em uma unidade de alimentação e nutrição da cidade de Goiânia – GO. *Demetra: Alimentação, Nutrição & Saúde* 10: 775–796.

Associação Brasileira Das Empresas De Refeições Coletivas (2020) Mercado Real: refeições, mão-de-obra empregada no setor de refeições coletivas e faturamento. Available at: https://www.aberc.com.br/mercadoreal (accessed 22 September 2020).

Beal JC, Fritz RE and Cozer M (2018) Índice de Resto Ingestão e Sobras Alimentares de um Serviço de Nutrição e Dietética Localizado no Sudoeste do Paraná. *Simbio-Logias* 10: 93–101.

Betz A, Buchli J, Göbel C, et al. (2015) Food waste in the Swiss food service industry – Magnitude and potential for reduction. *Waste Management* 35: 218–226.

Borges MP, Rodrigues Souza LH, de Pinho S, et al. (2019) Impacto de uma campanha para redução de desperdício de alimentos em um restaurante universitário. *Engenharia Sanitaria e Ambiental* 24: 843–848.

Brasil (2006) *Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Manual de gerenciamento de resíduos de serviços de saúde*. Brasília, Brazil: Agência Nacional de Vigilância Sanitária.

Brasil (2010) *Presidência da República do Brasil. Lei nº 12.305/2010. Institui a Política Nacional de Resíduos Sólidos; altera a Lei no 9.605, de 12 de fevereiro de 1998 e dá outras providências*. Brasília, Brazil: Diário Oficial da República Federativa do Brasil.

Britto APD and Oliveiro FGR (2017) Desperdício alimentar: Conscientização dos comensais de um serviço hospitalar de alimentação e nutrição. *Arquivos de Ciências da Saúde* 24: 61–64.

Bilck AP, et al. (2009) Aproveitamento de subprodutos: restaurantes de Londrina. *Revista em Agronegócios e Meio Ambiente* 2: 87–104.

Canonico FS, Pagamunici LM and Ruiz SP (2014) Avaliação de sobras e resto ingesta de um restaurante popular do município de Maringá-PR. *Revista Uningá* 19: 5–8.

Carvalho EM, Fonseca CS and Castro LCV (2013) Avaliação do índice de resto-ingestão e sobras em uma Unidade Produtora de Refeição (UPR). *Revista Higiene Alimentar* 27: 19–22.

Castro FAF and Queiroz VMV (2007) *Cardápios: planejamento e etiqueta* (22nd ed.). Viçosa: UFV, p. 97.

Colares LGT, Figueiredo VO and Mello A (2014) Lista de verificação de boas práticas ambientais em serviços de alimentação. 12o Ofício de Niterói – RJ: Registro de Títulos e Documentos no 74767, livro B-350, 2014. Available at: http://www.crn4.org.br (accessed 22 September 2020).

Copatti LC, Bruger VB, Baratto I, et al. (2018) Avaliação de resto de ingesta em uma unidade de alimentação e nutrição hospitalar na cidade de Pato Branco-PR. *Revista Brasileira de Obesidade, Nutrição e Emagrecimento* 12: 976–983.

Dias NA and Oliveira AL (2016) Sustentabilidade nas áreas de Alimentação e Nutrição: Desafios para o nutricionista no século XXI. *Revista Higiene Alimentar* 30: 26–31.

Dias-Ferreira C, Santos T and Oliveira V (2015) Hospital food waste and environmental and economic indicators – A Portuguese case study. *Waste Management* 46: 146–154.

Domingues CFS, Thomaz DPC, Simões DM, et al (2016) Geração de resíduos sólidos orgânicos em um restaurante universitário de São Paulo/SP. *Revista Meio Ambiente e Sustentabilidade* 10: 58–73.

Engström R and Carlsson-Kanyama A (2004) Food losses in food service institutions examples from Sweden. *Food Policy* 29: 203–213.

Eriksson M, Persson Osowski C, Malefors C, et al. (2017) Quantification of food waste in public catering services – A case study from a Swedish municipality. *Waste Management* 61: 415–422.

Falcomer AL, Santos Araújo L, Farage P, et al. (2018) Gluten contamination in food services and industry: A systematic review. *Critical Reviews in Food Science and Nutrition* 60: 479–493.

Fatel ECS, Fritz RE and Cozer M (2018) Avaliação do Índice de Resto Ingestão e Sobras do Almoço Servido no Refeitório de Uma Unidade de Alimentação e Nutrição Hospitalar Localizada no Oeste do Paraná. *Nutrição em Pauta* 148: 31–36.

Ferreira JA, dos Santos CHP, Pereira AJS, et al. (2012) Avaliação da sobra limpa e resto ingesta de um CEINF em Campo Grande-MS. *Ensaios e Ciência Ciências Biológicas, Agrárias e da Saúde* 16: 83–94.

Food and Agriculture Organization of The United Nations (2011) Global food losses and food waste: Extent causes and prevention. Roma. Available at: http://www.fao.org/3/mb060e/mb060e00.htm (accessed 16 October 2020).

Food Waste Reduction Alliance (FWRA) (2016) Analysis of U.S. food waste among food manufacturers, retailers, and restaurants. Available at: http://www.foodwastealliance.org/wp-content/uploads/2013/05/FWRA-Food-Waste-Survey-2016-Report_Final.pdf (accessed 20 March 2018).

Galian LCF, Santos SS and Madrona GS (2016) Análise do desperdício de alimentos em uma unidade de alimentação e nutrição. *Revista Geintec* 2: 3121–3127.

Halmenschlager W (2017) *Sustentabilidade Ambiental em Unidades de Alimentação e Nutrição Hospitalares da Região Sul do Rio Grande do Sul. 2017. 64 f*. Dissertação (Mestrado), Programa de Pós-Graduação em Nutrição e Alimentos, Faculdade de Nutrição, Universidade Federal de Pelotas, Pelotas.

Hatjiathanassiadou M, Souza SRGd, Nogueira JP, et al. (2019) Environmental impacts of university restaurant menus: A case study in Brazil. *Sustainability* 11: 1–15.

Issa RC, Moraes LF, Francisco RRJ, et al. (2014) Alimentação escolar: planejamento, produção, distribuição e adequação. *Revista Panamericana de Salud Pública* 35: 96–103.

Juffo EELD, Moraes IMA, Allegretti G, et al. (2016) Avaliação quantitativa e do grau de segregação dos resíduos sólidos orgânicos gerados em serviços de alimentação de um shopping center em Porto Alegre – RS. *Revista Higiene Alimentar* 30: 53–58.

Lima BTAN and Borges AF (2020) Alimentação fora do lar: fatores que influenciam consumidores a optarem por um restaurante fast-food. *Caderno Profissional De Marketing UNIMEP* 8: 1–8.

Longo-Silva G, Toloni MHA, Rodrigues S, et al. (2013) Qualitative evaluation of the menu and plate waste in public daycare centers in São Paulo city, Brazil. *Revista de Nutrição* 26: 135–144.

Lyra L (2008) *Avaliação da adequação de unidades produtoras de refeições do Distrito Federal quanto as normas ABNT NBR ISO 14001:2004 e 22000:2006. 64 f.* Dissertação (Especialização em Gastronomia e Saúde) – Centro de Excelência em Turismo. Universidade de Brasília, Distrito Federal.

Mello AG, Back FDS, Baratta R, et al. (2011) Avaliação do desperdício de alimentos em unidade de alimentação e nutrição localizada em um clube da cidade do Rio de Janeiro. *Revista Higiene Alimentar* 25: 33–39.

Moher D, Shamseer L, Clarke M, et al. (2015) Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 4: 1.

Moola S, Munn Z, Tufanaru C, et al. (2020) Chapter 7: Systematic reviews of etiology and risk. In: Aromataris E and Munn Z (eds) *JBI Manual for Evidence Synthesis*. Adelaide, Australia: JBI. Available at: https://synthesismanual.jbi.global

Moura PN, Honaiser A and Bolognini MCM (2009) Avaliação do índice de resto ingestão e sobras em Unidades de Alimentação e Nutrição (UAN) do colégio agrícola de Guarapuava (PR). *Revista Salus* 3: 15–22.

Nonino-Borges CB, Rabito EI, da Silva K, et al. (2006) Desperdício de Alimentos Intra – Hospitalar. *Revista de Nutrição* 19: 349–356.

Organização das Nações Unidas (ONU) (2015) Transformando Nosso Mundo: A Agenda 2030 para o Desenvolvimento Sustentável. Available at: https://brasil.un.org/sites/default/files/2020-09/agenda2030-pt-br.pdf (accessed 6 September 2022).

Painter K, Thondhlana G and Kua H (2016) Food waste generation and potential interventions at Rhodes University, South Africa. *Waste Management* 56: 491–497.

Papargyropoulou E, Steinberger JK, Wright N, et al. (2019) Patterns and causes of food waste in the hospitality and food service sector: Food waste prevention insights from Malaysia. *Sustainability* 11: 1–24.

Pospischek VS, Spinelli MGN and Matias ACG (2014) Avaliação de ações de sustentabilidade ambiental em restaurantes comerciais localizados no município de São Paulo. *Demetra* 9: 595–611.

Quested T and Parry A (2011) New estimates for household food and drink waste in the UK. *In Waste and Resources Action Programme* (WRAP). Available at: https://wrap.org.uk/resources/report/estimates-household-food-and-drink-waste-uk-2011 (accessed 22 September 2020).

Ricarte MPR, Fé MABM, Santos IHVS, et al. (2008) Avaliação do desperdício de alimentos em uma unidade de alimentação e nutrição institucional em Fortaleza/CE. *Saber Científico* 1: 158–175.

Sabino JB, Brasileiro NPM and Souza LT (2016) Pesquisa de resto-ingesta em uma Unidade de Alimentação e Nutrição hospital de Teófilo Otoni – MG. *Revista Higiene Alimentar* 30: 24–27.

Sakaguchi L, Pak N and Potts MD (2018) Tackling the issue of food waste in restaurants: Options for measurement method, reduction and behavioral change. *Journal of Cleaner Production* 180: 430–436.

Santos LL, Akutsu R, Botelho RBA, et al. (2012) Food service compliance with ISO 14001 and ISO 22000. *Revista de Nutrição* 25: 373–380.

Silva AM, Silva CP and Pessina EL (2010) Avaliação do índice de resto ingesta após campanha de conscientização dos clientes contra o desperdício de alimentos em um serviço de alimentação hospitalar. Rev. *Simbio-Logias* 3: 43–56.

Silva JS, Salomão JO, Peres DS, et al. (2019) Avaliação de resto-ingesta em unidade de alimentação e nutrição/Evaluation o frest-of-ingestion in food and nutrition unit. *Revista de Enfermeria* 13: e238574.

Silvennoinen K, Heikkilä L, Katajajuuri JM, et al. (2015) Food waste volume and origin: Case studies in the Finnish food service sector. *Waste Management* 46: 140–145.

Silvennoinen K, Nisonen S and Pietiläinen O (2019) Food waste case study and monitoring developing in Finnish food services. *Waste Management* 97: 97–104.

Silvério GA and Oltramari K (2014) Desperdício de alimentos em Unidades de Alimentação e Nutrição brasileiras. *Rev do Setor de Ciências Agrárias e Ambientais* 10: 125–133.

Soares ICC, da Silva ER, Priore SE, et al. (2011) Quantificação e análise do custo da sobra limpa em unidades de alimentação e nutrição de uma empresa de grande porte. *Revista de Nutrição* 24: 593–604.

Sonnino R and McWilliam S (2011) Food waste, catering practices and public procurement: A case study of hospital food systems in Wales. *Food Policy* 36: 823–829.

Souza CAN, Longo-Silva G, Menezes RCG, et al. (2018) Adequação nutricional e desperdício de alimentos em Centros de Educação Infantil. *Revista Ciência & Saúde Coletiva* 23: 4177–4188.

Stone J, Garcia-Garcia G and Rahimifard S (2019) Development of a pragmatic framework to help food and drink manufacturers select the most sustainable food waste valorisation strategy. *Journal of Environmental Management* 247: 425–438.

Strasburg VJ and Jahno VD (2017a) Application of eco-efficiency in the assessment of raw materials consumed by university restaurants in Brazil: A case study. *Journal of Cleaner Production* 161: 178–187.

Strasburg VJ and Jahno VD (2017b) Paradigmas das práticas de gestão ambiental no segmento de produção de refeições no Brasil. *Engenharia Sanitaria e Ambiental* 22: 3–12.

Tayra F and Ribeiro H (2006) Modelos de indicadores de sustentabilidade: síntese e avaliação crítica das principais experiências. *Saúde e Sociedade* 15: 84–95.

Vaz CS (2003) *Alimentação de coletividade: uma abordagem gerencial. Manual Prático do gestor de serviços de refeições coletivas*. Brasília: Metha; 2003.

Veiros MB et al (2009) Food safety practices in a Portuguese canteen. *Food Control* 20: 936-941.

Veiros MB and Proença RPC (2010) Princípios de sustentabilidade na produção de refeições. *Nutrição em Pauta* 102: 45–49.

Viana RM and Ferreira LC (2017) Avaliação do desperdício de alimentos em unidade de alimentação e nutrição cidade de Januária, MG. *Revista Higiene Alimentar* 31: 22–26.

Wang LE, Liu G, Liu X, et al. (2017) The weight of unfinished plate: A survey based characterization of restaurant food waste in Chinese cities. *Waste Management* 66: 3–12.

Yu Y, et al. (2010) Assessing regional and global water footprints for the UK. Ecol. Ecol. Econ. 69:1140e1147. http://doi.org/10.1016/j.ecolecon.2009.12.008

Zandonadi HS and Maurício AA (2012) Avaliação do índice de resto-ingesta, de refeições consumidas por trabalhadores da construção civil no município de Cuiabá, MT. *Revista Higiene Alimentar* 26: 64–70.

Zorpas AA, Lasaridi K, Abeliotis C, et al. (2014) Waste prevention campaign regarding the waste framework directive. *Fresenius Environmental Bulletin* 23: 2876–2883.

Zorpas AA, Lasaridi K, Voukkali I, et al. (2015) Promoting sustainable waste prevention strategy activities and planning in relation to the waste framework directive in insular communities. *Environmental Processes* 2: 159–173.

Zotesso J, Cossich E, Colares L, et al. (2016) Analysis of solid waste generation in a university cafeteria in Brazil: A case study. *Environmental Engineering and Management Journal* 18: 294–308.