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## Food safety and hygiene practices of vendors during the chain of street food production in Florianopolis, Brazil: A cross-sectional study



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### ABSTRACT

The aims of this study were to assess the compliance of street foods sold in an urban center in a major capital of Brazil with international standards for food safety and to provide data that could be used for the elaboration of specific legislation to ensure the safety of street food. The study investigated demographic profiles of street vendors and hygiene practices used in critical points of food production for products sold. Direct observations and structured interviews were conducted among vendors at stationary locations in the downtown area. Forty-three participating vendors were mostly males who generally completed only elementary school. Among observed food safety risks: 12% of the vendors did not provide ice at the point of sale for perishable ingredients; 95% did not wash hands between food and money transactions and restroom breaks; 91% did not have hair coverings and 100% of the vendors did not have access to a water supply. The interviews revealed that 12% of the vendors did not provide proper cold holding during transportation; 33% did not wash their hands at all, whereas 24% only used water to wash their hands; and 33% never took the required food-handling course. The study indicates a need for improvements of the environmental conditions at these sites to prevent foodborne diseases. Specific local and national laws for street food need to be created to protect the consumer, and continuous training of vendors could help address the lack of food quality and safety.

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### 1. Introduction

The street food trade is an ancient practice (Taylor et al., 2000) common in several countries (WHO, 1996) as a source of income. It is a provision of inexpensive meals accessible to the population, and can also represent the culture of typical and local food (Lucca & da Silva Torres, 2006; Mosupye & von Holy, 2000; Moy, Hazzard, & Kaferstein, 1997). The World Health Organization (1996) defines street food as foods and beverages prepared and sold by vendors in streets and other public places for immediate consumption (WHO, 1996). Due to a lack of basic infras-

tructure such as water connections and refrigeration, the sanitary quality at these venues may be compromised, becoming a public health risk to the consumer. Risk factors at these locations could affect food safety at critical points such as purchasing, which includes criteria used in the selection of raw materials. Other critical points involve hygienic practices utilized during transport of products to the vending site, and the preparation of mixed ingredients, as well as cooking, storing, serving, sanitizing and waste management practices (Costarrica & Morón, 1996; Donkor, Kayang, Quaye, & Akyeh, 2009; FAO, 2009b; Rane, 2011; WHO, 1996; FDA, 2014). There has been an international call to increase the safety of food sold on the street that encompasses all stages of the food production chain. There are rudimentary global guidelines in place (Rane, 2011; FAO, 2002; FAO, 2010). However, the literature has predominantly uncovered inadequate sanitary conditions in street food venues (Hanashiro, Morita, Matté, Matté, & Torres, 2005; Lucca & da Silva Torres, 2006; Nunes et al., 2010; Rodrigues et al., 2003).

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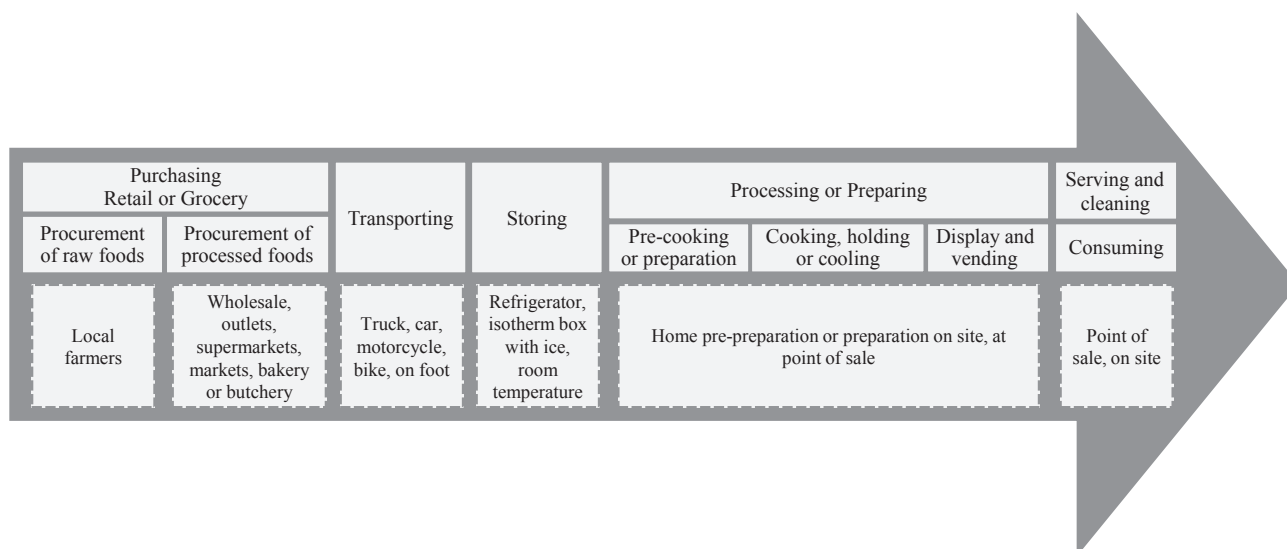


Fig. 1. Stages of street food production chain.

Therefore, the overall goal of this study was to assess whether street foods sold in an urban center in a major capital of southern Brazil met international standards for food safety across all stages of food production. Contingent objectives were to investigate the demographic profile of the street food vendors and to provide data that could be used for the elaboration of specific legislation.

## 2. Material and methods

### 2.1. Subject

A cross-sectional descriptive study was conducted to analyze the food safety conditions of all mobile street food-vending locations in the downtown area in Florianópolis, Santa Catarina (SC) – Brazil. For the purpose of this investigation a mobile food street cart was defined as a food-vending unit that is brought on wheels to a standard location. Addresses indicated on a registration list and maps provided by the city Hall were used to comprise a comprehensive list of street vendors. The following inclusion criteria were considered: *a*) the food or beverages must be ready for consumption and sold on public streets and *b*) the carts must be structurally mobile, but must be located in standard, consistent locations (Brazil, 2004). As such, out of a total of 74 venues registered in the city, some of the locations were excluded because 3 were fixed kiosks, 3 were duplicated on the city records and 5 were ambulant street hawkers. Additionally, 15 vendors could not be located and 5 refused to participate in the study. Therefore, the study encompassed a total of 43 vending locations that sold the following: only popcorn (15), only peanuts and coconut candy (2), only corn-on-the-cob (2), only coconut water made directly from whole coconuts (2), corn-on-the-cob and coconut water (3), barbecue meat, soda and water (3), *churros* – similar to donuts (2), hot dogs and beverages (7), processed candies (6) and strawberry *bonbons* (1). The investigators were allowed to conduct the interviews and allowed to observe food production at the researched food locations.

### 2.2. Instruments and data collection techniques

The researchers of this study sought to identify aspects that could compromise food safety at each stage of the food production chain, from acquisition of raw materials to service to the consumer.

The investigators followed an adaptation of the steps proposed by Barro et al. (2007), as Fig. 1 illustrates.

#### 2.2.1. Data collection

Data collection was performed in two different ways: direct observation and interview. For the direct observation a checklist with close-ended questions was used to guide the points to be observed. Furthermore, an interview was conducted in-person, guided by a close-ended questionnaire with categorical/multiple-choice nominal questions. The interview was conducted in person to support more accuracy and completeness of the questionnaire. The instruments were developed based on international technical documents (FAO/WHO, 2001; FAO/WHO, 2009; FAO, 2009a, 2009b, 2010; WHO, 1996, 2006) and national legislation on good practice and hygiene requirements for food (Brazil, 2004). A pre-test of the instruments was conducted utilizing data collected from street food venues in a nearby town. The direct observation was used primarily at the point of sale and guided by an innovative checklist. The interview was mostly used to uncover the purchasing, processing and transportation activities that took place prior to the point of sale. The data was triangulated to present an overall picture of the street vendor's food safety practices. The study was approved by the Ethics Committee in Research with Human Beings (CEPSH) of the Federal University of Santa Catarina (UFSC) (Protocol 2306). The participants signed an Informed Consent that ensures anonymity.

#### 2.2.2. Instruments

The checklist was used to evaluate food safety points subject to immediate inspection (e.g. food handling practices at the point of sale). The checklist with close-ended questions (yes, no, not applicable and not observed) was divided into three categories, comprising 93 closed questions about the physical structure of the facility (surfaces, lighting, water supply, etc), the supply chain of street foods (purchasing practices) and the food vendors' sanitary practices (food handling). The structured questionnaire analyzed issues of specific knowledge (e.g. education, food acquisition and production practices). The questionnaire was divided into four categories totaling 43 items, with categorical/multiple-choice nominal questions. The categories included socio-demographic characteristics (gender, age, education); food characteristics (the type of foods sold); characteristics of acquiring raw ingredients and ready-to-eat food (the source, purchasing criteria and the supplier); storage

**Table 1**  
Demographic characteristics of the street food vendors, Florianopolis, SC, Brazil.

	n (43)	%
<b>Sex</b>		
Female	18	42
Male	25	58
<b>Age (years)</b>		
20–39	11	25.2
40–59	18	41.9
≥60	12	27.9
No answer	2	4.6
<b>Education</b>		
Illiterate	1	2.3
Primary school	8	18.6
Elementary school	21	48.8
High school	10	23.3
University	2	4.7
No answer	1	2.3

conditions (for the preservation of raw ingredients and food ready for consumption during transportation from the home or market to the point of sale); characteristics of the selling point (type of point of sale, location, site hygiene, water availability); food handling practices; and the personal hygiene of the vendors.

### 2.3. Statistical analysis

The checklist and the questionnaire data including demographic information were entered into Microsoft Office Excel 2007 with double entry for further confidence. The statistical program Stata® 11.0 (StataCorp, College Station, TX, USA) was used for descriptive analysis with calculation of absolute and relative frequency. Information obtained from the checklist was categorized as adequate or inadequate by comparing to international food safety regulations and calculating the suitability of each variable percentage.

## 3. Results

### 3.1. Profile of street food vendors

Of the 43 street food vendors interviewed, 58% were male, 42% were aged between 40 and 59 years and 49% had completed only elementary school. The complete profile of vendors is shown in Table 1. Additionally, fourteen vendors (33%) reported noncompliance due to never completing a mandatory food handling course that needs to be retaken every two years. Of the 29 vendors (67%) who took the course, the median time between retaking the course was 18 months (see Table 3). No correlations among demographic data and food safety practices were observed in the analyzed interview data with the following insignificant exceptions: Male street food vendors were more concerned with verifying the product expiration dates at the purchase point ( $M = 23$ ,  $F = 12$ ) and during storage ( $M = 22$ ,  $F = 12$ ), separating cleaning products from food ( $M = 24$ ,  $F = 14$ ), and checking the validity of data labels (product name, preparation and expiration date) ( $M = 11$ ,  $F = 1$ ). Responding females were more concerned about the use of ice during transportation ( $M = 2$ ,  $F = 7$ ) and at the point of sale ( $M = 1$ ,  $F = 7$ ) and also, with avoidance of product cross-contamination ( $M = 6$ ,  $F = 9$ ).

### 3.2. Product description

Of the 43 vending locations observed, 79% ( $n = 34$ ) were mobile carts, 14% ( $n = 6$ ) were mobile stalls and 7% ( $n = 3$ ) were adapted cars. Fifty-six percent of the carts were parked in commercial areas, 16% in public squares and 28% near to bus terminals. A considerable amount of snacks and processed products (e.g.

sweets and soft drinks) were served in these locations. Seventy-six percent of the foods sold were made at home, 30% commercially processed and 11% whole natural products (e.g. coconut water and corn). The percentage exceeds 100% because, as described at 2.1, there was an overlap between items of food sold by vendors. The only local food offered was corn-on-the-cob, which is a typical regional product. The complete list of products sold at the street food locations is described in Fig. 2.

### 3.3. Purchasing

The information on purchasing was culled from the interviews. This data showed that the vendors bought their products from wholesale outlets, supermarkets, bakeries (inside and outside of supermarkets) and outside butchers, whereas strawberries and corn for the most part were purchased directly from local farmers. The purchasing venues for raw materials and ingredients are described in Fig. 3. The product attribute that vendors considered the most important for purchasing ingredients was appearance, cited by 35% ( $n = 15$ ). According to the vendors, if a food product has a good appearance when purchased, this ensures a greater quality of the final products sold. However, in the decision to choose a supplier, 56% ( $n = 24$ ) of the vendors prioritized overall pricing. Eighty-one percent ( $n = 35$ ) of the vendors reported that they checked the expiration date of the raw materials at the point of purchase, and 63% ( $n = 27$ ) of the vendors inspected the purchasing venues prior to deciding where to purchase ingredients. Furthermore, 37% ( $n = 16$ ) of the vendors rejected one or more of the purchasing venues due to poor hygienic conditions and high prices. Only 19% ( $n = 8$ ) of the vendors reported that they checked the temperature at the time of purchase for products requiring refrigeration or freezing. Detailed information is shown in Table 3.

### 3.4. Transport of ingredients and pre-prepared products

Data generated through interviews on the transportation of ingredients indicated that the main method for bringing ingredients from the home to the point of sale (the cart) was a private car, as reported by 44% ( $n = 19$ ) of the street vendors. Nineteen percent of street vendors ( $n = 8$ ) reported transporting perishable foods (e.g. meat for barbecue, hot dogs and home-made tomato sauce) from the home or market to the cart with ice, whereas 12% of the vendors ( $n = 5$ ) reported not using ice when transporting these products. Bakery products, such as *bonbons*, *churros*, toppings and fillings, were reportedly transported in plastic bags at ambient temperature (about 27 °C or 81 °F) (IFSC, 2012). The ambient temperature is based on the average temperature during the time of observation. More details are shown in Table 3.

### 3.5. Storage

At the point of sale, 91% ( $n = 39$ ) of the vendors stored foods separately without debris, thus avoiding cross-contamination between raw and cooked products. Forty of the vendors (93%) reported storing food separately from cleaning products. Five of the vendors (12%) reported that they did not keep pre-prepared perishable foods (e.g., sausage and tomato sauce for hot dogs; meat for barbecue and *dulce de leche* – reduced sweetened milk) on ice and none of these vendors reported changing the ice throughout the day. Seven percent of the vendors (7%,  $n = 3$ ) reported storing dough in plastic bags at ambient temperature at the point of sale. More detailed information is shown in Tables 2 and 3.

### 3.6. Cooking and serving points

Results revealed that 76% ( $n = 33$ ) of the vendors used foods that were substantially pre-prepared at home and some only

Table 2

Abbreviated checklist of street food vendors.

Items observed with checklist *NA: not applicable; NO: not observed	YES (n,%)	NO (n,%)	NA* (n,%)	NO* (n,%)
<b>Point of Sale</b>				
Surround vicinity free of sources of contamination <sup>1,2</sup>	36 (84.0)	7 (16.0)	0 (0.0)	0 (0.0)
Suitable place to park the cart	36 (84.0)	1 (2.0)	6 (14.0)	0 (0.0)
Facilities of cart well protected when not in use	28 (64.0)	5 (12.0)	8 (19.0)	2 (5.0)
Clean surfaces and free of personal items <sup>1,2</sup>	33 (77.0)	9 (21.0)	1 (2.0)	0 (0.0)
Adequate lighting in the food preparation area <sup>2</sup>	17 (40.0)	5 (12.0)	21 (48.0)	0 (0.0)
Connectivity to water supply <sup>2</sup>	0 (0.0)	43 (100.0)	0 (0.0)	0 (0.0)
Suitable water storage container <sup>2</sup>	10 (23.0)	2 (5.0)	31 (72.0)	0 (0.0)
Proper waste management <sup>2</sup>	15 (35.0)	19 (44.0)	8 (19.0)	1 (2.0)
Clean, maintained and protected equipment <sup>1,2</sup>	31 (72.0)	4 (9.0)	8 (19.0)	0 (0.0)
Clean, maintained and protected utensils <sup>1,2</sup>	26 (60.0)	6 (14.0)	11 (26.0)	0 (0.0)
Separate utensils for each food or preparation (raw or cooked and ready-to-eat)	13 (30.0)	12 (28.0)	18 (42.0)	0 (0.0)
<b>Meal production</b>				
Suitable storage and maintenance of foods at point of sale <sup>2</sup>	20 (46.0)	5 (12.0)	18 (42.0)	0 (0.0)
Foods are stored separately without debris in a clean, organized and suitable conservation status at point of sale <sup>1,2</sup>	39 (91.0)	4 (9.0)	0 (0.0)	0 (0.0)
Storage the perishable food at the cart, holding cold	8 (19.0)	2 (5.0)	32 (74.0)	1 (2.0)
Storage the perishable food at the cart, holding hot	24 (56.0)	2 (5.0)	16 (37.0)	1 (2.0)
Foods are stored separately from cleaning products at point of sale <sup>2</sup>	40 (93.0)	2 (5.0)	1 (2.0)	0 (0.0)
Food meeting safety standards at point of sale <sup>2</sup>	38 (88.0)	3 (7.0)	2 (5.0)	0 (0.0)
Foods exposed to sale are properly covered, chilled or heated	37 (86.0)	4 (9.0)	2 (5.0)	0 (0.0)
Food packaging meeting standards <sup>2</sup>	22 (51.0)	2 (5.0)	19 (44.0)	0 (0.0)
Pre-prepared or ready-to-eat foods are handled with pertinent utensils, without manual contact	34 (79.0)	1 (2.0)	8 (19.0)	0 (0.0)
Food served to client without direct contact to newspaper, used or recycled paper	42 (98.0)	0 (0.0)	1 (2.0)	0 (0.0)
Immediate disposal of leftovers	22 (51.0)	10 (23.0)	11 (26.0)	0 (0.0)
Clean production surface areas <sup>2</sup>	31 (72.0)	4 (9.0)	2 (5.0)	6 (14.0)
<b>Food handler (vendors)</b>				
Appropriate uniform <sup>1,2</sup>	18 (42.0)	20 (46.0)	5 (12.0)	0 (0.0)
Not use jewelry	10 (23.0)	33 (77.0)	0 (0.0)	0 (0.0)
Protection covering completely the hair	4 (9.0)	39 (91.0)	0 (0.0)	0 (0.0)
Fingernails clean, short and without varnish	23 (53.0)	20 (47.0)	0 (0.0)	0 (0.0)
Adequate vendor cleanliness <sup>1,2</sup>	22 (51.0)	13 (30.0)	8 (19.0)	0 (0.0)
Appropriate hygienic habits <sup>1,2</sup>	17 (40.0)	26 (60.0)	0 (0.0)	0 (0.0)
Wash hands before and after transaction between foods, potential contaminants, and using restroom	2 (5.0)	41 (95.0)	0 (0.0)	0 (0.0)
Does not handle money during the activity, and when handle wash hands before handling food <sup>2</sup>	2 (5.0)	41 (95.0)	0 (0.0)	0 (0.0)
Satisfactory sanitary facilities in outer vicinity <sup>2</sup>	29 (67.0)	8 (19.0)	5 (12.0)	1 (2.0)

Items observed and analyzed according general food safety Brazilian's Law: <sup>1</sup> Lei nº 2496/1986; <sup>2</sup> RDC nº 216/2004.

needing reheating. Thirty percent (30%,  $n = 13$ ) of the vendors used foods that were industrial processed whereas 11% ( $n = 5$ ) used directly (not pre-prepared) natural products, including corn-on-the-cob and coconut water. Nine (75%) of the 12 vendors that used condiment dispensers (e.g. mayonnaise and ketchup) stated that they refilled dispensers. Six vendors (14%) offered homemade mayonnaise (made from milk, oil, salt, pepper and vinegar) on their cart. All the vendors serving this product reported that it was made without eggs, to reduce the potential for bacteriological contamination. Any leftover food was reportedly immediately disposed by 51% ( $n = 22$ ) of the vendors, whereas 23% ( $n = 10$ ) took the leftovers for personal consumption at home. The types of leftover mostly disposed were homemade mayonnaise, sausage, tomato sauce, preserved corn and pea, and vegetables used for hot dogs. All of the condiments at the point of sale were kept at ambient temperature.

Street food vendors (67%,  $n = 29$ ) reported washing their hands on average 4 times a day while working, whereas 33% ( $n = 14$ ) did not wash hands at all during working. From those who washed their hands, only 24% ( $n = 7$ ) reported using water only. Detergents were used mostly to sanitize equipment, reported by 21% ( $n = 6$ ) of the vendors even though detergent itself is not a sanitizer. During observations, it was also identified that 95% ( $n = 41$ ) of the vendors cross-manipulated money and food without sanitizing their hands. Seventy-nine percent ( $n = 34$ ) of the vendors used utensils to serve food, avoiding manual contact, while 28% ( $n = 12$ ) of the vendors used the same utensil among raw, cooked and ready-to-consume foods to manipulate and serve the food. Results are reported in Tables 2 and 3

#### 4. Discussion

The majority of the vendors were male, which is inconsistent with the predominance of studies around the world finding street vendors to be predominantly women (Choudhury, Mahanta, Goswami, Mazumder, & Pegoo, 2011; Muinde & Kuria, 2005; Sun, Wang, & Huang, 2012; Ackah et al., 2011; Chukuezi, 2010; Donkor et al., 2009; FAO, 2012; Mensah, Yeboah-Manu, Owusu-Darko, & Ablordey, 2002; Muyanja, Nayiga Brenda, & Nasinyama, 2011; Omemu & Aderoju, 2008; Alves da Silva et al., 2014; Sampundo, Climat, Xhaferi, & Devlieghere, 2015; Low, Jani, Halim, Alias, & Moy, 2016). However, most vendors were between 40 and 59 years old, which is consistent with the literature (Adjrah et al., 2013; Alves da Silva et al., 2014; Choudhury Mahanta, Goswami, Mazumder, & Pegoo, 2011; Hanashiro et al., 2005; Muyanja, Nayiga, Brenda, & Nasinyama, 2011). The findings of this study indicated that responding men were more concerned about the validity of data labels (the product name, preparation date and expiration date), while responding females were more concerned about the use of ice for product preservation, and the avoidance of cross-contamination ( $M = 6$ ,  $F = 9$ ). These main findings are in accordance with food handling practices in the Al-Shabib, Mosilhey, and Husain (2015) study, where the vendors were concerned with checking and throwing away expired food. These vendors, to avoid cross-contamination, used different utensils and cutting-boards while they were preparing raw and cooked food at the same time. Almost 83% of the street food vendors in this study followed these procedures.

**Table 3**  
Abbreviated questionnaire of street food chain.

Questions and number of respondent vendors	Yes		No		NA*	
	N	%	N	%	N	%
*NA: no answer or no applicable						
<b>Most important attribute in the purchase of raw materials/ingredients?(n 43)</b>					3	7.0
Appearance	15	35.0				
Brand	11	26.0				
Price	10	23.0				
Expiration date	3	7.0				
Overall quality	1	2.0				
<b>Most important attribute for choosing a food supplier (n 43)</b>					4	9.0
Cleanliness of the establishment	5	12.0				
Price	24	56.0				
Proximity to the point of sale	4	9.0				
Overall quality	6	14.0				
<b>Visits to the food supplier (n 43)</b>	30	70.0	8	18.0	5	12.0
<b>Visit prior to first purchase (n 43)</b>	27	63.0	3	7.0	13	30.0
<b>Visit after first purchase (n 43)</b>	3	7.0	27	63.0	13	30.0
<b>Purchasing stopped after the first visit (n 43)</b>	16	37.0	22	51.0	5	12.0
Raw materials meeting safety standards at point of purchase (procurement)	29	68.0	3	7.0	11	25.0
Check the expiration date and the conservation status at the moment of purchase	35	81.0	2	5.0	6	14.0
The temperature of perishable foods is checked at the moment of purchase	8	19.0	0	0.0	35	81.0
Proper storage and preservation of food with ice during transportation	20	46.0	8	19.0	15	35.0
<b>Transportation (n 43)</b>						
Walking	9	21.0				
Car	19	44.0				
Bus	2	5.0				
Motorcycle	1	2.0				
Cart of sale	12	28.0				
<b>Identifying the food, date of preparation and expiration date during transportation from point of purchase to point of sale (n 43)</b>	15	35.0	28	65.0		
<b>Pre-preparation of food (n 51 – multiple answer)</b>						
At home (vendors use food prepared at home)	33	76.0				
Factory (pre-processed or processed)	13	30.0				
Natural Products (no preparation, e.g. corn-on-the-cob, coconut water)	5	11.0				
<b>Transportation and Storage at point of sale (n 43)</b>						
Pre-prepared perishable foods packaged kept in cool boxes with ice (e.g. tomato sauce, hot dog, meat for barbecue, canned sweet corn and peas, shredded carrots)	8	19.0	5	12.0	30	69.0
Sodas and juices	17	40.0	4	9.0	22	51.0
Read-to-eat and bakery products (bonbons, churro dough) are maintained in plastic bags at room temperature	3	7.0			40	93.0
<b>Add sauce or other ingredient before selling the food? (n 43)</b>	12	27.9	31	72.1		
<b>What do you use to serve the sauces? (n 12)</b>						
Reusable dispensers	9	75.0				
Individual package	1	8.0				
Original package (e.g. margarine, pepper sauce, processed sauce for barbecue)	2	17.0				
<b>What kind of product or sauce do you serve? (n 12)</b>						
Processed sauces (mayonnaise, ketchup, pepper and barbecue sauce)	6	50				
Homemade mayonnaise and processed sauces (ketchup, pepper sauce)	6	50				
<b>To make homemade sauce, like mayonnaise, do you make with: (n 6)</b>						
Pasteurized milk	6	100.0				
Eggs (raw or hard broiled)	0	0.0				
<b>Do you sanitize reusable dispensers every day? (n 9)</b>	8	88.9	1	11.1		
<b>Source of water to cook food (n 16)</b>						
From home	12	75.0				
From stores	3	19.0				
Other	1	6.0				
<b>Water to prepare food (n 16)</b>						
Spring water	3	19.0				
Boiled or filtered water	0	0.0				
Tap water	13	81.0				
<b>Place to store the water to prepare food (n 16)</b>						
Container (closed)	12	75.0				
Other (pan with lid)	4	25.0				
<b>Frequency of 'sanitizing'<sup>a</sup> at the point of sale (n 37)</b>						
Opening	7	19.0				
Closing	10	27.0				
Opening and closing	19	51.0				
Other (e.g. many times during work time)	1	3.0				
<b>Products used to 'sanitize'<sup>a</sup> at the point of sale (n 35 – multiple answer)</b>						
Chlorine solution	5	14.0				
Alcohol	10	27.0				
All-purpose cleaner product	7	20.0				
Saponaceous	1	3.0				
Detergent	21	60.0				
Soap bar	8	23.0				
Other	4	11.0				

(continued on next page)

Table 3 (continued)

Questions and number of respondent vendors	Yes		No		NA*	
	N	%	N	%	N	%
*NA: no answer or no applicable						
<b>Hand-washing during work (n 43)</b>	29	67.0	14	33.0		
Frequency of hand-washing (n 29)	Median: 4 times per day; Variance: 1–10					
<b>Location of hand-washing (n 29)</b>						
Point of sale	15	52.0				
Store close to point of sale	9	31.0				
Other (e.g. tap on the street, public restroom)	5	17.0				
<b>Product used for hand-washing (n 29)</b>						
Just water	7	24.0				
Liquid hand soap	11	38.0				
Liquid soap	1	3.0				
Detergent	6	21.0				
Other	4	14.0				
<b>Hand-drying (n 29)</b>						
Paper towel	12	42.0				
Towel	16	55.0				
I do not dry	1	3.0				
<b>Supplementary hand-washing (n 29)</b>	17	59.0	12	41.0		
<b>Products used for supplementary hand-washing (n 29)</b>						
Alcohol	9	31.0				
Alcohol gel for hands	8	28.0				
Other	12	41.0				
<b>Use of restrooms (n 43)</b>						
Did not use the restroom during the work hours	7	16.0				
Stores close to point of sale	11	26.0				
Public restrooms	25	58.0				
<b>Food-handling course (n 43)</b>	29	67.0	14	33.0		
<b>Length of time passed since taking the food-handling course (n 29)</b>	Median: 18 months; Variance: 2–84					

<sup>a</sup> Based on the vendors' interpretation of sanitization.

Apart from the targeted food in this study, a considerable amount of snacks and processed products (sweets and soft drinks) were also sold on the carts. These products offered the benefits of convenience, lower cost and long shelf life, and relative food safety. However, most of these foods were energy dense, with high amounts of sugar, fat, salt and preservatives (Steyn & Labadarios, 2011; Steyn et al., 2014.), which could contribute to the issues of public obesity and chronic diseases (Brazil, 2008; Buscemi et al., 2011; Popkin, 2006).

The results revealed that the majority of those responsible for product acquisition checked the expiration date and the state of conservation of raw materials, as recommended by the Brazilian legislation and the *Codex Alimentarius* (Brazil, 2004; FAO/WHO, 2001; FAO/WHO, 2009). However, only 35% of the observed foods in storage had labels identifying the food, date of preparation, and the expiration date, as required (Brazil, 2004). This situation is comparable with the international literature on street food labeling conditions (Choudhury et al., 2011; Cuprasitrit, Srisorachatr,

& Malai, 2011), but not consistent with international standards (Brazil, 2004; FAO/WHO, 2001; FAO/WHO, 2009).

The street vendors reported transporting ingredients and prepared foods from home and markets by cars, carts, buses, motorcycles and walking, but not in refrigerated vehicles nor using isothermal containers. In accordance with Brazilian and international recommendations, 19% of the vendors reported holding perishable foods on ice during transport to the point of sale (FAO/WHO, 2001; FAO/WHO, 2009; WHO, 1996), while 12% reported that they did not store perishable foods on ice during transportation. Among street vendors that reported storing foods on ice, none of them had means or opportunity to replenish or change the ice over the course of operations. A similar situation was observed in another study, where cooked foods were kept cool in an icebox or refrigerator by a minority of the vendors (30%) (Samapundo et al., 2015). This situation is potentially hazardous due to prolonged exposure to the generally high ambient temperatures typical of the local climate (Alves da Silva et al., 2014). As observed, some stored foods were floating in water inside the icebox when the ice melted.

At the point of sale, nine of the vendors reported reusing dispensers for condiments. This would be illegal in another city in Brazil, which has specific laws for street food vendors (São Paulo, 1993), but not in the city where the present investigation was conducted (Florianópolis, 2002, 2003). It was reported, though not confirmed, that 22% of the vendors took leftovers to home for consumption, fitting the model reported in similar investigations (Alves da Silva et al., 2014; Muinde & Kuria, 2005). However, it is not completely clear whether the vendors reused leftovers in subsequent days for production within or outside of statutory regulations.

Earlier studies have identified the point of service as the most critical step for potential contamination of street food (Liu, Zhang, & Zhang, 2014; Proietti, Frazzoli, & Mantovani, 2014). The lack of running water or potable water storage makes food safety

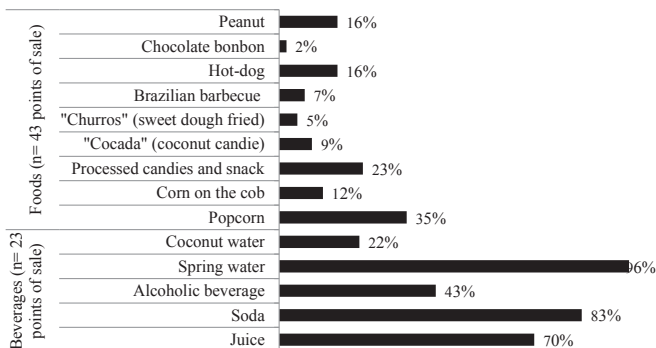


Fig. 2. Percentage of food and beverage sold in downtown Florianópolis, SC, Brazil.

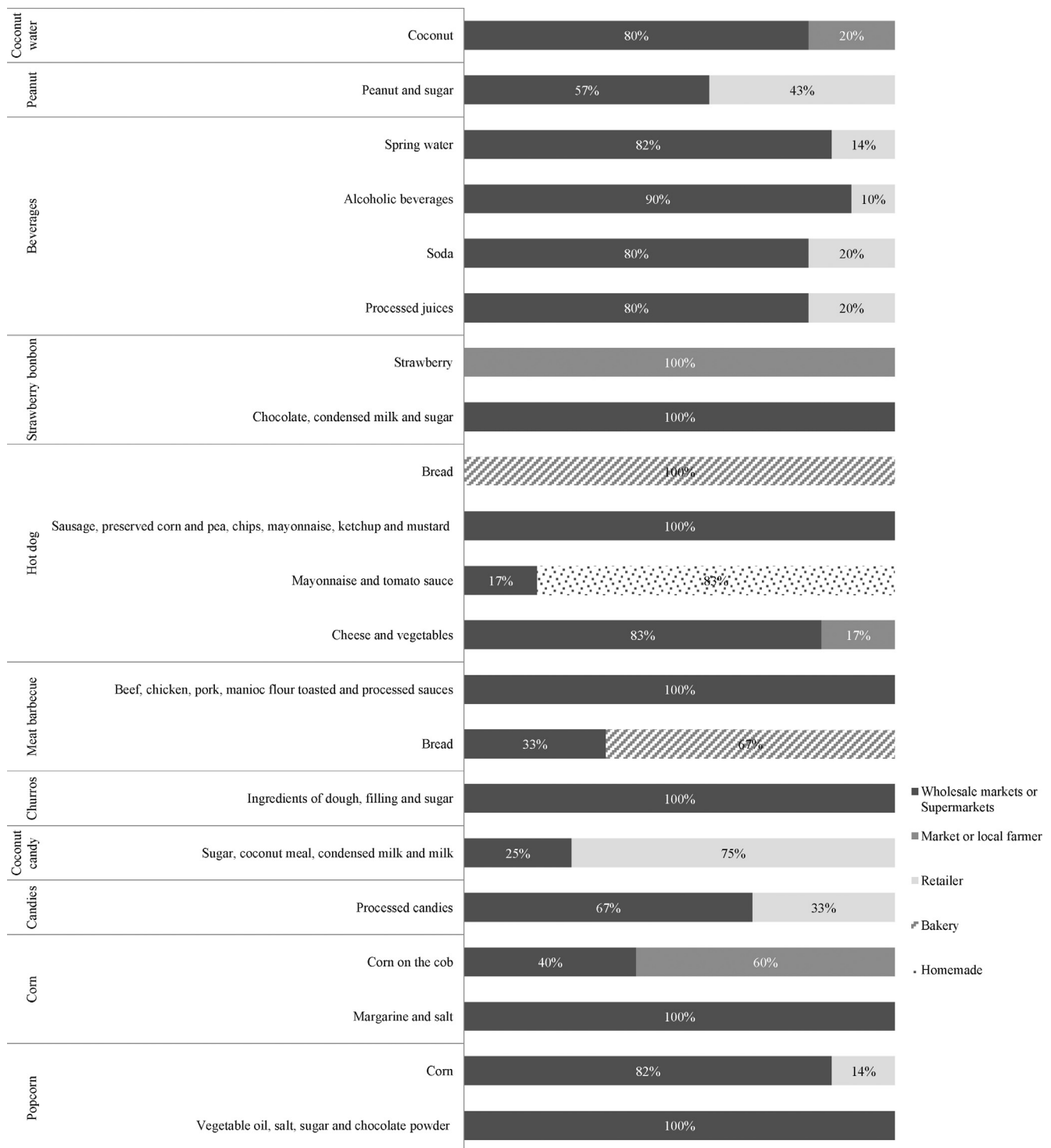


Fig. 3. Sources for purchase of raw material or ingredients to prepare food sold by street vendors in downtown Florianopolis, SC, Brazil.

conditions at these locations untenable, as water is needed for washing food, hands, utensils and equipment and for proper food preparation procedures (Omemu & Aderoju, 2008; Proietti et al., 2014; Rane, 2011). Without proper washing facilities, the vendors become likely vectors of food contaminants. Of great concern is that many vendors of the present study reportedly did not wash their hands or used only water for this purpose during production. The situation was exacerbated when vendors used the same utensil to serve raw and cooked foods and mixed the handling of money with the serving of food, thus exchanging commodities

with others who are also unlikely to have recently taken sanitation precautions (Brazil, 2004; Muinde & Kuria, 2005). This observed situation was a consequence of the multiple functions (food preparation and services as well as collection of payment) performed by individual vendors at each point of sale and is consistent with the findings of international literature (Chukuezi, 2010; Muinde & Kuria, 2005; Alves da Silva et al., 2014; Nunes et al., 2010; Samapundo et al., 2015).

The general education level of the vendors more-or-less exceeded that of the general Brazilian population (IBGE, 2010),

though many of them did not complete the necessary food course requirement. Several positive food safety efforts made by many of the street vendors along the production chain were identified. This includes buying foods with regulated packaging and labels, checking expiration dates, using utensils to handle the food, not adding eggs in the preparation of homemade mayonnaise sauce and proper storage of most foods during transportation and at point of sale (Brazil, 2004; WHO, 1996). However, several factors could lead to contamination of foods and consequently increase public health risks: lack of water supply at the point of sale; improper storage of perishable foods during transportation and at point of sale; handling of money and food by the same person; low frequency of hand hygiene; lack of vendors' compliance with food safety training; and scarcity of sanitary and proper waste disposal facilities (Campos, Gil, Mourao, Peixe, & Antunes, 2015; Cardoso, Santos, & Silva, 2009; Muyanja et al., 2011; Omemu & Aderoju, 2008; Proietti et al., 2014; Rane, 2011).

Ultimately, assuring public food safety at the street level may be more cost-effective than providing medical care for those afflicted with foodborne, pathogenic diseases (Barro et al., 2007; Muyanja et al., 2011; Omemu & Aderoju, 2008). However, current international legislative requirements for food cart safety are sparse or inconsistent. For example, Sydney Australia has requirements for food trucks, food vans and temporary food stalls, but these guidelines are not explicit for street food handling practices (City of Sydney, n.d.). New York City (NYC) has specific rules for mobile food vending units (Class D – non-potentially hazardous unpackaged food including frankfurters, sausages and pastries), but these guidelines do not require hand washing or ware-washing facilities for these operations (City of Toronto, nd.) and do not explain how street cart food vendors can address these safety issues. While cities around the world are attempting to address food safety regulations for street food, the lack of infrastructure and the absence of a general administrative understanding of the particularities of these operations hinder the development of effective legislation.

## 5. Conclusions

This study suggests that improvements are needed in food-handling education, government regulation and infrastructure for street food vendors. The street food vendors' food handling practices in most cases were below international standards, which are inconsistent. This investigation supports the need for the formulation of specific standard regulations for this sector, which includes supervisory actions that ensure proper hygienic practices. Standard laws, particularly for street foods, must also be enacted on local and national levels, as the current international regulations for these venues are sparse. The demography of the vendors revealed that the vendors were mostly male, middle-aged and lacked extended formal education. This investigation provides data necessary for the development of policies and standards that will help insure the safety of street foods. Such regulation can include strongly enforced requirements for licensure and the public provision of more comprehensive free courses that address food-handling practices on the street food level. It is important to continuously inform street food vendors about good hygiene practices at all stages of the production chain. While regulation and education are crucial for continuous food safety, ignoring an inadequate infrastructure can undermine public health initiatives. The basic infrastructure for maintaining street food safety should include proper access to waste facilities and water supply, presence of sanitary and proper waste management, and regular monitoring and supervision by authorities. Future research should be developed that encompasses microbiological analysis of foods served at these locations.

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