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Food intake markers in Sisvan: temporal trends in coverage and integration with e-SUS APS, Brazil 2015–2019

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Abstract *The aim of the present study was to estimate the population coverage of recording food intake markers in Brazil's Food and Nutrition Surveillance System (Sisvan) and mean annual percent change (APC) in coverage according to the system used for data entry (e-SUS APS and Sisvan Web). We conducted an ecological time series study of the period 2015–2019. The data were stratified into region and age group. APC in coverage was calculated using Prais-Winsten regression and the correlation between APC and HDI, GDP per capita and primary healthcare coverage was assessed using Spearman's correlation coefficient. Population coverage of recording food intake markers at national level was 0.92% in 2019. Mean APC in coverage throughout the period was 45.63%. The region and age group with the highest coverage rate were the Northeast (4.08%; APC=45.76%, p<0.01) and children aged 2-4 years (3.03%; APC=34.62%, p<0.01), respectively. There was an upward trend in data entry using e-SUS APS, to the detriment of Sisvan Web. There was a positive correlation between APC in coverage using e-SUS APS and HDI and GDP per capita in some age groups. Population coverage of recording Sisvan food intake markers remains low across the country. The e-SUS APS has the potential to be an important strategy for expanding food and nutrition surveillance.*
Key words *Food and Nutrition Surveillance, Health Information Systems, Time Series*

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Introduction

Improving diet and nutrition depends on a range of factors, including the promotion of healthy eating practices and disease prevention and care[1,2]. Studies show that exposure to risk factors attributable to food intake, including a diet high in sugar-sweetened beverages and processed meats and low in low in fruits and vegetables, accounted for 13.5% of attributable deaths worldwide among females and 14.6% in males in 2019[3].

The World Health Organization recognizes that health surveillance systems are important tools for monitoring these factors, highlighting the importance of representativeness of data and frequency of data collection[4]. In Brazil, food and nutrition surveillance (FNS) actions are carried out by the primary care services of the country's public health system, the *Sistema Único de Saúde* (SUS) or Unified Health System[2]. Relevant data is recorded in the Food and Nutrition Surveillance System (Sisvan), providing a unique opportunity for ongoing monitoring. To identify essential dietary elements throughout different stages of the life course, the Sisvan proposes the use of food intake markers[2], which are tools for screening dietary practices and intake of different food groups. These markers refer to selected items of food intake during the previous day and can be used by different types of health professionals[2]. While food markers do not reveal the detailed habitual daily intake of a food, they are suitable for use in primary care as a substitute for specialized methods for assessing nutrients[5]. The analysis of the data produced by these tools can help plan and monitor programs, actions and the work of health professionals with individuals, groups and catchment areas[1].

Despite the importance of monitoring, evidence shows that the food intake component of the Sisvan is underused. Up to 2013, less than one-third of the country's municipalities had at least one record of food intake in the system. In the same year 0.40% the Brazilian population who do not have private health insurance had records of food intake in the Sisvan, with coverage increasing 0.05% per year (95%CI: 0.01; 0.09) in the period 2008-2013[6].

In view of this situation, a revised version of food intake markers was proposed in 2015 in line with the recommendations of the second edition of the Dietary Guidelines for the Brazilian Population. To simplify data collection and encourage the recording of data, the forms are based on intake during the previous day and can be used by all primary care workers[2]. The Ministry of Health also published a technical guidance note on the integration of the SUS's primary care health record system, e-SUS APS, and Sisvan's online platform, Sisvan Web[7]. The integration of these two systems helps reduce the duplication of efforts by health professionals through single data entry in primary care services, helping to promote an increase in the population coverage of FNS actions[8], which is essential to improve the representativeness of data[9].

The aim of the present study was to estimate temporal trends in the population coverage of recording of Sisvan food intake markers at national level in the period 2015-2019. The estimates were stratified by age, region and system used for data entry to provide evidence on e-SUS APS' contribution to FNS actions. Finally, we also explored potential correlations with primary care coverage and sociodemographic variables.

Methods

Study design and data sources

We conducted an ecological time series study of population coverage of recording of Sisvan food intake markers at national level in the period 2015-2019. In the current format, food intake markers are recorded using one of three forms[10]: (i) exclusive breastfeeding for children aged under 6 months; (ii) introduction of complementary foods, identifying the risk of micronutrient deficiency and overweight in children aged between 6 months and 23 months and 29 days; and (iii) healthy and unhealthy behaviors and markers based on the consumption of food groups and exposure to ultra-processed foods by individuals aged over 2 years.

Launched in 2013, the aim of e-SUS APS is to promote greater integration between national primary care service health information systems[11]. Primary care professionals have two alternatives for inputting FNS data: Sisvan Web, which also receives data from the cash transfer initiative *Programa Bolsa Família*; and the Electronic Citizen Record and Simplified Data Collection software via e-SUS APS[10]. In 2016, the entry of the patient's National Health Card number in Sisvan Web was made mandatory with the aim of integrating the systems. The records contained in the e-SUS APS up to 2015 were gradually incorporated into Sisvan Web. The incorporation of data ensures that all records, regardless of the

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system used, are contained in the reports produced by the Sisvan[10,12]. The integration of the two systems was consolidated in 2017[7].

Based on the revised Sisvan forms, the annual number of individuals with records of food intake markers between 2015–2019 was obtained using publicly available annual reports[13] and information requests made to Ministry of Health's General Office for the Coordination of Food and Nutrition. The data were extracted between October 2020 and May 2021.

For the sociodemographic variables and primary care coverage during the study period, we used secondary data from the Brazilian Institute of Geography and Statistics (IBGE)[14,15], annual human development reports[16], the Human Development Atlas[17], and the Primary Care Information and Management System[18]. The study was conducted in accordance with the editorial policy of the Ministry of Health (Ministerial Order 884/2011)[19] governing the transfer of data from the national databases of the information systems managed by the Department of Health Care. The study protocol was approved by the University of São Paulo's School of Public Health's ethics committee (reference 4.172.787).

Data analysis

We calculated annual utilization of Sisvan food intake marker forms in the period 2015-2019 by dividing the number of municipalities with at least one record of food intake markers in the system by the total number of municipalities in the country and multiplying by 100[6]. Population coverage of recording of food intake markers was calculated using the ratio between the number of individuals with at least one record in the system and the total resident population[14] multiplied by 100. Annual coverage was calculated at national, regional, and state level and stratified into life stages: children aged under 2, children aged 2-4, children aged 5-9, adolescents (10-19 years), adults (20-59 years), and older persons (60 years and over). In addition to total coverage, in all groups coverage was stratified according to the system used for data entry (e-SUS APS or Sisvan Web).

Temporal trends in coverage were analyzed using Prais-Winsten regression, which allowed us to estimate the annual percent change (APC) using generalized linear regression, which considers first-order serial autocorrelation, as described by Antunes and Cardoso[20]. Serial autocorrelation is the dependence of a serial measure on its past values and indicates violation of the assumption of independence of the residuals, which is required for simple linear regression analysis[20]. These considerations are particularly interesting for the investigation of coverage of a health surveillance system whose structure at a point in time may be related to its past performance. In the Prais-Winsten regression, run using the *prais* command, the dependent variable was the log-transformed value for coverage (base 10) and the independent variable was the year of the record. The resulting coefficient was used to calculate the APC in population coverage of recording food intake markers, based on the following formula:

$$APC = [-1 + (10^{\beta})] \times 100$$

Where: APC = annual percent change; β = coefficient resulting from Prais-Winsten regression (log base 10).

A 5% significance level was adopted for the analysis, where significant p-values (<0.05) indicated that the time series displayed either an upward or downward trend in coverage (positive or negative APC value, respectively). Non-significant p-values (≥0.05) indicated that the time series was stationary.

The APC in population coverage of recording food intake markers is presented at national and regional level and by life stage, according to system used for data entry (total, e-SUS APS or Sisvan Web). Temporal trends in total coverage of recording food intake markers by state are presented in maps by life stage.

The analysis of the sociodemographic variables and primary care coverage was performed using Prais-Winsten regression, informing the APC in the human development index (HDI), gross domestic product (GDP) per capita, and primary care coverage during the study period. Primary care coverage was calculated by dividing the total number of people registered with primary care services by the total population and multiplying by 100[21].

Dependence between APC in population coverage of recording food intake markers (total, e-SUS APS or Sisvan Web) and primary care coverage by life stage and sociodemographic characteristics was measured using Spearman's correlation coefficient. Based on the information available at state level, the following variables were considered in the analysis: HDI (2016), GDP per capita (2015), primary care coverage (2015), and average annual variation in primary care coverage (2015-2019).

The statistical analyses were performed using Stata 11.2 (Stata Corp, College Station, TX, USA). The maps were created using Microsoft Excel 2016.

Results

Table 1 shows sociodemographic characteristics, primary care coverage, utilization of food intake marker forms, and population coverage of recording food intake markers at national level in the period 2015-2019. All variables display an upward trend. In 2019, 62.24% of the municipalities in Brazil used Sisvan forms (APC: +20.05%; p=0.04). Total population coverage in Brazil rose from 0.20% in 2015 to 0.92% in 2019 (APC: +45.63%; p<0.01).

Tables 2 and 3 show population coverage of recording food intake markers between 2015-2019 and APC for children, adolescents, adults, and older persons at national and regional level according to system used for data entry. At national level, in 2019, total population coverage of recording using both e-SUS APS and Sisvan Web was lowest in adults (0.62%) and highest in children aged 2-4 (3.03%). All life stages showed upward temporal trends in total population coverage of recording food intake markers at national level. The highest APC over the study period at national level was among children aged 5-9 (+63.58%; p<0.01). At regional level, upward temporal trends were observed across all locations and age groups, except children aged under 2 in the Mid-West and Southeast and children aged 2-4 in the Southeast, where the series was trend-stationary.

Coverage of recording using e-SUS APS showed an upward trend across all life stages. At national level, significant annual changes in recording of markers using e-SUS APS ranged from +75.01% in children aged under 2 to +98.10% among children aged 5-9. At regional level, total population coverage of recording food intake markers using e-SUS APS displayed an upward temporal trend across all strata except children aged under 2 in the Mid-West.

In contrast, coverage of recording using Sisvan Web showed stationary temporal trends at national level in various life stages, including children aged under 2, children aged 2-4 years, and adults. Downward trends in population coverage of recording using Sisvan Web was observed in the Mid-West (children aged 2-4, adolescents, adults, and older persons) and North (adolescents, adults, and older persons). Only the South showed an upward temporal trend in coverage of reporting using this system (among children aged 2-9 and adolescents).

Figure 1 shows temporal trends in total population coverage of recording food intake markers in the states. Most of the states showed upward or stationary trends over the study period. Exceptions included: the Federal District, in children aged under 2 (-43.28%; p=0.01), adults (-40.33%; p=0.01), and older persons (-46.17%; p=0.02); Roraima, among children aged under 2 (-29.52%; p=0.02) and adults (-26.31%; p=0.04); and Tocantins, in children aged under 2 (-15.59%; p=0.02) (data not shown).

Table 4 shows the correlation between APC in population coverage of recording food intake markers between 2015 and 2019 by life stages and HDI, GDP per capita, and primary care coverage. Although associations with APC in overall coverage were not found, it is interesting to note that APC in coverage of reporting using e-SUS APS among children and older persons was positively related to some factors. A significant positive moderate correlation was found between HDI and coverage of reporting using e-SUS APS among children aged under 2 (rho=0.41; p=0.03) and aged 2-4 (rho=0.41; p=0.03), and between GDP per capita and coverage of reporting using e-SUS APS in children under 2 (rho=0.48; p=0.01) and older persons (rho=0.42; p=0.03).

Discussion

At national level, temporal trends in recording of Sisvan food intake markers were upward across all life stages over the study period. This finding is accompanied by a positive trend in the percentage of municipalities that use these forms. However, total population coverage is low, limiting the representativeness of the data. This analysis makes an original contribution to existing knowledge on this subject by stratifying the results by the system used to input FNS data and providing insights into the contribution of the e-SUS APS.

An analysis of nutrition surveillance in low-income countries showed that cross-sectional surveys, community-based sentinel monitoring, and data collection in schools were the primary sources of FNS data and suggested that data obtained from health systems are suitable secondary sources provided they are interpreted with contextual information[22]. In a recent sys-

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Table 1. Sociodemographic characteristics, primary care coverage, utilization and recording of food intake markers in the Food and Nutrition Surveillance System. Brazil, 2015-2019.

Year	HDI[a]	GDP per capita (R$)[b]	PHC (%)[c]	Utilization (%)[d]	Coverage (%)[e]
2015	0.754	29466.85	72.89	28.60	0.20
2016	0.758	30558.75	73.80	46.37	0.39
2017	0.759	31843.95	73.64	56.50	0.50
2018	0.761	33593.82	74.79	61.53	0.81
2019	0.765	35161.70	73.69	62.24	0.92
TIA (%)[f]	0,30*	4,59*	0,51*	20,05*	45,63*

Notes: a) Human development index (HDI)16. b) Gross domestic product (GDP) per capita17. c) Primary Health Care (PHC) coverage: total number of people registered with primary care services divided by the total population multiplied by 10018. d) Number of municipalities with at least one record of food intake markers divided by the total number of municipalities in the country. e) Population coverage of recording of food intake markers using Food and Nutrition Surveillance System forms: number of registered individuals divided by the total population multiplied by 100. Refers to both forms of data entry (e-SUS APS and Sisvan Web). f) Annual percentage change (APC) calculated using the formula [-1+(10^β)]×100, where que β is the coefficient resulting from Prais-Winsten regression20. *P-values<0.05.

Source: Authors.

Table 2. Population coverage of recording food intake markers in the Food and Nutrition Surveillance System among children – total and by system used for data entry. Brazil, 2015-2019.

	Population coverage (%)[a]					APC (%)[b]	p-value	Trend[c]
	2015	2016	2017	2018	2019			
Children under 2								
Mid-West	1.12	1.81	1.22	1.32	0.82	-10.06	0.11	Stationary
e-SUS APS	0.07	0.68	0.46	0.91	0.73	+58.06	0.07	Stationary
Sisvan Web	1.06	1.40	0.91	0.52	0.17	-37.03	0.04	Downward
Northeast	0.61	1.41	1.09	2.31	3.12	+41.85	<0.01	Upward
e-SUS APS	0.27	1.13	0.78	1.82	2.35	+54.29	<0.01	Upward
Sisvan Web	0.34	0.28	0.31	0.49	0.77	+24.03	0.09	Stationary
North	0.88	1.60	1.11	1.60	1.70	+11.31	0.04	Upward
e-SUS APS	0.15	0.56	0.54	1.08	1.17	+57.60	0.01	Upward
Sisvan Web	0.73	0.44	0.43	0.42	0.46	-8.78	0.19	Stationary
Southeast	0.87	2.90	4.24	4.54	4.05	+41.72	0.09	Stationary
e-SUS APS	0.05	0.77	0.89	1.89	2.10	+117.48	0.03	Upward
Sisvan Web	0.82	2.13	3.36	2.65	1.95	+21.76	0.32	Stationary
South	1.03	1.55	1.81	2.77	2.26	+29.27	0.01	Upward
e-SUS APS	0.09	0.77	0.87	1.88	1.66	+91.77	0.03	Upward
Sisvan Web	0.94	0.78	0.94	0.89	0.59	-5.06	0.27	Stationary
Brazil	0.84	2.07	2.44	3.09	3.01	+33.19	0.04	Upward
e-SUS APS	0.13	0.88	0.78	1.70	1.89	+75.01	0.01	Upward
Sisvan Web	0.71	1.19	1.66	1.39	1.12	+11.23	0.37	Stationary

it continues

tematic literature review, the main hosts of food and nutrition dashboards around the world were inter-governmental and non-governmental organizations, universities, and research institutions, especially in the United States[23]. Other studies suggest that the presence of government structures for coordination of FNS was decisive for the sustainable development of activities[24,25]. The shift in health surveillance systems towards monitoring a broad range of risk factors for chronic diseases, including food intake markers, has given rise to a number of challenges, resulting in the

Table 2. Population coverage of recording food intake markers in the Food and Nutrition Surveillance System among children – total and by system used for data entry. Brazil, 2015-2019.

	Population coverage (%)[a]					APC (%)[b]	p-value	Trend[c]
	2015	2016	2017	2018	2019			
Children aged 2-4								
Mid-West	0.75	1.64	1.37	2.05	1.66	+18.27	0.03	Upward
e-SUS APS	0.08	0.88	0.78	1.67	1.47	+81.88	0.04	Upward
Sisvan Web	0.67	1.05	0.73	0.47	0.28	-23.18	0.07	Stationary
Northeast	0.87	1.52	1.41	3.12	4.08	+45.76	<0.01	Upward
e-SUS APS	0.25	1.19	1.09	2.30	3.06	+68.83	0.01	Upward
Sisvan Web	0.62	0.33	0.32	0.82	1.02	+21.79	0.29	Stationary
North	1.62	1.71	1.80	2.90	3.15	+21.33	0.01	Upward
e-SUS APS	0.24	0.86	1.03	1.88	2.19	+65.71	0.01	Upward
Sisvan Web	1.32	0.85	0.65	0.94	0.88	-6.66	0.45	Stationary
Southeast	0.97	1.76	2.49	2.89	2.58	+27.79	0.05	Stationary
e-SUS APS	0.05	0.48	0.64	1.39	1.62	+116.72	0.02	Upward
Sisvan Web	0.92	1.28	1.84	1.50	0.96	+2.15	0.86	Stationary
South	0.61	1.08	1.70	3.69	2.99	+71.42	<0.01	Upward
e-SUS APS	0.09	0.61	1.23	2.45	2.30	+116.89	0.02	Upward
Sisvan Web	0.51	0.46	0.47	1.24	0.68	+25.65	0.03	Upward
Brazil	0.94	1.63	1.91	2.98	3.03	+34.62	<0.01	Upward
e-SUS APS	0.14	0.79	0.90	1.86	2.16	+83.73	0.01	Upward
Sisvan Web	0.80	0.84	1.01	1.12	0.87	+7.54	0.17	Stationary
Children aged 5-9								
Mid-West	0.27	0.59	0.51	0.94	1.09	+35.57	<0.01	Upward
e-SUS APS	0.04	0.42	0.37	0.81	0.91	+91.35	0.03	Upward
Sisvan Web	0.24	0.32	0.19	0.16	0.22	-13.23	0.07	Stationary
Northeast	0.26	0.45	0.43	1.62	2.29	+77.08	0.01	Upward
e-SUS APS	0.09	0.38	0.32	0.89	1.54	+85.20	<0.01	Upward
Sisvan Web	0.18	0.08	0.11	0.73	0.76	+74.79	0.09	Stationary
North	0.62	0.52	0.61	1.14	1.39	+27.92	0.04	Upward
e-SUS APS	0.09	0.24	0.44	0.73	0.93	+77.06	<0.01	Upward
Sisvan Web	0.53	0.28	0.24	0.38	0.43	-0.81	0.95	Stationary
Southeast	0.16	0.30	0.58	0.92	1.02	+62.12	<0.01	Upward
e-SUS APS	0.02	0.14	0.17	0.47	0.70	+130.83	0.01	Upward
Sisvan Web	0.14	0.16	0.41	0.45	0.33	+32.82	0.07	Stationary
South	0.16	0.36	0.69	1.93	1.61	+11.83	<0.01	Upward
e-SUS APS	0.03	0.25	0.55	1.22	1.18	+145.98	0.02	Upward
Sisvan Web	0.13	0.12	0.14	0.71	0.44	+64.51	0.02	Upward
Brazil	0.25	0.42	0.55	1.28	1.51	+63.58	<0.01	Upward
e-SUS APS	0.05	0.26	0.30	0.75	1.04	+98.10	<0.01	Upward
Sisvan Web	0.20	0.16	0.25	0.53	0.47	+39.83	0.02	Upward

Notes: a) Total number of individuals registered in the Sisvan database by age group and region divided by total population of each municipality multiplied by 100. b) Annual percentage change (APC) calculated using the formula $[-1+(10^\beta)]\times100$, where β is the coefficient resulting from Prais-Winsten regression20. c) A 5% significance level was adopted. Non-significant p-values ($p\geq0.05$) indicate a stationary trend and significant p-values ($p<0.05$) indicate an upward or downward trend (positive or negative APC value).

Source: Authors.

need for the ongoing evaluation of system performance[25].

This work contributes to initiatives assessing elements of coverage and, consequently, the representativeness of Sisvan records. Coverage is one of the most commonly addressed aspects of performance in evaluations of health information systems in Brazil[26], with a focus on vital statistics in live births[27] and mortality[28] information systems.

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Table 3. Population coverage of recording f food intake markers in the Food and Nutrition Surveillance System among adolescents, adults and older persons – overall and by system used for data entry. Brazil, 2015-2019.

	Population coverage (%)[a]					APC (%)[b]	p-value	Trend[c]
	2015	2016	2017	2018	2019			
Adolescents								
Mid-West	0.20	0.43	0.37	0.62	0.66	+29.23	<0.01	Upward
e-SUS APS	0.04	0.32	0.27	0.58	0.61	+77.80	0.03	Upward
Sisvan Web	0.16	0.11	0.10	0.04	0.05	-31.35	<0.01	Downward
Northeast	0.16	0.26	0.21	0.51	0.59	+53.16	0.02	Upward
e-SUS APS	0.05	0.20	0.15	0.40	0.84	+78.36	<0.01	Upward
Sisvan Web	0.11	0.06	0.06	0.11	0.18	+16.91	0.39	Stationary
North	0.41	0.41	0.46	0.68	0.84	+21.32	0.03	Upward
e-SUS APS	0.05	0.18	0.23	0.51	0.59	+78.73	<0.01	Upward
Sisvan Web	0.36	0.33	0.23	0.19	0.25	-14.64	0.03	Downward
Southeast	0.09	0.18	0.36	0.55	0.52	+58.70	0.01	Upward
e-SUS APS	0.01	0.09	0.11	0.29	0.34	+110.45	0.01	Upward
Sisvan Web	0.08	0.09	0.25	0.26	0.18	+33.48	0.09	Stationary
South	0.08	0.24	0.45	0.83	0.85	+82.73	0.01	Upward
e-SUS APS	0.02	0.18	0.38	0.67	0.74	+141.83	0.03	Upward
Sisvan Web	0.06	0.06	0.07	0.16	0.11	+31.63	0.02	Upward
Brazil	0.15	0.27	0.34	0.59	0.76	+48.75	<0.01	Upward
e-SUS APS	0.03	0.17	0.18	0.42	0.59	+91.48	0.01	Upward
Sisvan Web	0.12	0.10	0.15	0.18	0.17	+15.57	0.02	Upward
Adults								
Mid-West	0.16	0.45	0.37	0.62	0.57	+30.06	0.02	Upward
e-SUS APS	0.03	0.35	0.28	0.58	0.55	+76.76	0.04	Upward
Sisvan Web	0.13	0.11	0.09	0.03	0.03	-38.39	0.01	Downward
Northeast	0.12	0.24	0.21	0.43	0.79	+50.65	0.01	Upward
e-SUS APS	0.04	0.19	0.16	0.38	0.71	+81.24	<0.01	Upward
Sisvan Web	0.08	0.05	0.05	0.05	0.08	-0.55	0.95	Stationary
North	0.29	0.34	0.45	0.64	0.76	+30.58	<0.01	Upward
e-SUS APS	0.04	0.17	0.25	0.50	0.56	+85.93	0.01	Upward
Sisvan Web	0.25	0.23	0.20	0.14	0.20	-13.85	0.01	Downward
Southeast	0.08	0.17	0.31	0.49	0.45	+59.60	0.01	Upward
e-SUS APS	0.01	0.09	0.11	0.28	0.32	+105.79	0.01	Upward
Sisvan Web	0.06	0.07	0.20	0.21	0.13	+29.91	0.14	Stationary
South	0.07	0.24	0.45	0.71	0.76	+77.26	0.01	Upward
e-SUS APS	0.02	0.19	0.39	0.63	0.71	+134.61	0.03	Upward
Sisvan Web	0.06	0.05	0.06	0.08	0.05	+8.51	0.13	Stationary
Brazil	0.11	0.24	0.32	0.53	0.62	+51.71	<0.01	Upward
e-SUS APS	0.02	0.16	0.19	0.40	0.52	+94.79	0.01	Upward
Sisvan Web	0.09	0.08	0.13	0.13	0.10	+10.58	0.16	Stationary

it continues

In the first analysis of utilization and coverage of food intake markers at national level, Nascimento *et al.*[6] reported that 32.5% of municipalities in Brazil used the system in 2013, with coverage of 0.40%. Using the latest version of the food intake markers, the present study showed that utilization and total population coverage were lower in 2015 (28.6% and 0.20%, respectively). Logistical problems during the adaptation of work processes to the new forms and the launch of Sisvan Web version 3.0 in 2017, providing a tool to merge records and reduce duplications[29],

Table 3. Population coverage of recording f food intake markers in the Food and Nutrition Surveillance System among adolescents, adults and older persons – overall and by system used for data entry. Brazil, 2015-2019.

	Population coverage (%)[a]					APC (%)[b]	p-value	Trend[c]
	2015	2016	2017	2018	2019			
Older persons								
Mid-West	0.28	0.77	0.64	1.05	1.23	+34.90	0.01	Upward
e-SUS APS	0.06	0.60	0.52	1.01	1.14	+78.20	0.03	Upward
Sisvan Web	0.21	0.17	0.12	0.04	0.03	-42.24	<0.01	Downward
Northeast	0.12	0.30	0.26	0.54	1.02	+56.82	<0.01	Upward
e-SUS APS	0.06	0.26	0.22	0.49	0.92	+76.86	<0.01	Upward
Sisvan Web	0.06	0.05	0.04	0.04	0.10	+8.11	0.54	Stationary
North	0.45	0.50	0.75	1.12	1.32	+36.74	<0.01	Upward
e-SUS APS	0.08	0.50	0.54	1.01	1.05	+73.45	0.02	Upward
Sisvan Web	0.37	0.34	0.21	0.11	0.27	-27.52	0.03	Downward
Southeast	0.15	0.29	0.51	0.80	0.76	+54.27	0.01	Upward
e-SUS APS	0.02	0.17	0.21	0.48	0.57	+105.67	0.01	Upward
Sisvan Web	0.13	0.12	0.30	0.31	0.19	+23.41	0.15	Stationary
South	0.10	0.39	0.72	1.11	1.27	+84.74	0.02	Upward
e-SUS APS	0.03	0.31	0.66	0.99	1.18	+134.45	0.04	Upward
Sisvan Web	0.07	0.07	0.06	0.12	0.09	+12.80	0.12	Stationary
Brazil	0.16	0.36	0.50	0.82	0.90	+53.45	<0.01	Upward
e-SUS APS	0.04	0.28	0.32	0.63	0.74	+90.80	0.02	Upward
Sisvan Web	0.12	0.11	0.18	0.19	0.16	+15.22	0.04	Upward

Notes: a) Total number of individuals registered in the Sisvan database by age group and region divided by total population of each municipality multiplied by 100. b) Annual percentage change (APC) calculated using the formula [-1+(10^β)]×100, where β is the coefficient resulting from Prais-Winsten regression20. c) A 5% significance level was adopted. Non-significant p-values (p≥0.05) indicate a stationary trend and significant p-values (p<0.05) indicate an upward or downward trend (positive or negative APC value).

Source: Authors.

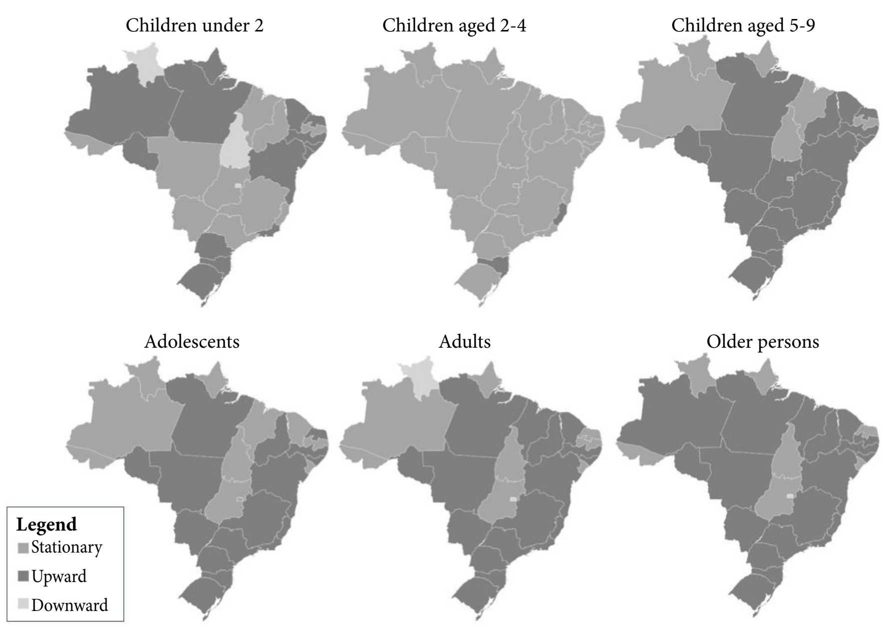

Figure 1. Maps showing temporal trends in population coverage of recording food intake markers in the Food and Nutrition Surveillance System across states, 2015-2019.

Source: Authors.

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Table 4. Correlations between sociodemographic characteristics and primary health coverage and annual percent change in population coverage of recording of food intake markers in the Food and Nutrition Surveillance System – overall and by system used for data entry. Brazil, 2015-2019.

APC in coverage of recording of food intake markers[a]	GDP per capita[b]		HDI[c]		APC in PHC coverage[d]	
	rhoe	p-value	rho	p-value	rho	p-value
Children under 2	-0.29	0.14	-0.35	0.07	-0.01	0.97
e-SUS APS	**0.48**	**0.01**	**0.41**	**0.03**	-0.09	0.66
Sisvan Web	-0.22	0.27	-0.23	0.24	0.09	0.66
Children aged 2-4	-0.04	0.84	-0.14	0.50	0.35	0.07
e-SUS APS	**0.37**	**0.05**	**0.41**	**0.03**	-0.06	0.78
Sisvan Web	-0.09	0.67	-0.16	0.42	0.21	0.29
Children aged 5-9	0.04	0.84	-0.08	0.67	0.35	0.08
e-SUS APS	0.28	0.15	0.33	0.10	-0.31	0.11
Sisvan Web	-0.07	0.73	-0.06	0.76	0.20	0.31
Adolescents	0.05	0.79	-0.06	0.75	0.36	0.07
e-SUS APS	0.37	0.06	0.26	0.19	-0.16	0.43
Sisvan Web	-0.01	0.97	0.05	0.79	0.17	0.39
Adults	0.08	0.69	-0.12	0.56	0.36	0.06
e-SUS APS	0.30	0.13	0.23	0.26	-0.31	0.12
Sisvan Web	-0.13	0.52	-0.09	0.65	0.20	0.31
Older persons	0.03	0.88	-0.05	0.79	0.21	0.29
e-SUS APS	**0.42**	**0.03**	0.29	0.15	-0.16	0.42
Sisvan Web	-0.15	0.45	-0.01	0.96	0.22	0.28

Notes: a) Annual percentage change (APC) calculated using the formula [-1+(10^β)]×100, where β is the coefficient resulting from Prais-Winsten regression20. b) Gross domestic product (GDP) per capita in 201515. c) Human development index (HDI) in 201617. d) Primary Health Care (PHC) coverage calculated based on the total number of people registered with primary care services divided by the total population multiplied by 10018. e) Spearman's correlation coefficient. Statistically significant values are in bold.

Source: Authors.

may have affected the estimates. However, for comparison purposes, it is important to consider the denominator employed by each study. Nascimento *et al.*[6] used the SUS patient population approach, excluding private health service users. In the present study, in line with recent analyses of coverage[30], we opted to use total resident population, while at the same time minimizing potentially inconsistent values, given that primary care coverage exceeded 100% in 12 states when private health service users were subtracted.

Temporal trends in coverage of recording of Sisvan food intake markers were upward throughout the study period, with an APC of +45.63% and reaching 0.92% of the national population. Two considerations are important in this regard. First, APC is a proportional metric obtained using the Prais-Winsten procedure, which improves the management of time series data[20] and provides insights into system performance. Notwithstanding methodological differences, using simple linear regression without serial autocorrelation, Nascimento *et al.*[6] estimated that the crude variation in national coverage between 2008 and 2013 was 0.05%. Second, it is important to consider that, in absolute terms, total population coverage of recording food intake markers remains very low, compromising the achievement of the goals of FNS[25] when it comes to diagnosing, monitoring, and predicting food intake and nutritional status using APS with greater population representativeness.

Given that there is substantial room for improving the coverage of the system, the analytical approaches explored in the present analysis shed light on how to create pathways to improving the evaluation of food intake markers using Sisvan. Against a backdrop of low coverage, rates among children aged up to 4 were higher than in all other life stages in 2019, supported by an upward temporal trend throughout the study period. In addition to the traditional link between the Sisvan Web and monitoring of conditioning factors for children's health in the programs Milk is Health, Incentives for Combating Nutrient Deficiencies, and *Bolsa Família*, two studies have highlighted the role played by the National Strategy for Healthy Complementary Feeding in stimulating the collection of data on food intake markers[31,32]. More recently, the recording of food intake markers was made mandatory in the programs "Health at School" (*Saúde na Escola* - PSE) and "Grow up Healthy" (*Crescer Saudável* - PCS)[2,33], which may partially explain the marked increases noted in children aged 5-9. Intersectoral actions developed in schools reach schoolchildren, who often fail to perform health check-ups with the recommended frequency[2].

The Northeast had the highest absolute coverage in children aged 2-9 years and adults, while the South showed the highest relative increase across most age groups. In contrast, the Southeast displayed the lowest absolute coverage rates in children aged 5 years and over, which may be explained by the region's high population density. The data from the Mid-West suggest the need to stimulate local performance, with the region having the lowest coverage rate in children aged under 5 and lowest APC across most life stages.

With regard to system used for data entry, the findings show overall stability or downward trends for recording using Sisvan Web and an upward trend for data entry using e-SUS APS during the study period. While it is possible to enter FNS data in e-SUS APS and generate reports showing FNS indicators via Sisvan Web[21], it is important to note that e-SUS APS has not been adopted as a single FNS data entry system by all municipalities and that some Sisvan Web functions – such as the identification of priority groups and epidemiological surveillance strategies using customization tools – have yet to be included in e-SUS APS[29]. The use of e-SUS APS has increased across the country in recent years. In 2019, 92.2% of municipalities displayed a level of implementation different to "not implemented"[34], which is in line with recent international discussions on health data integration[35]. However, the findings do not allow us to infer that e-SUS APS utilization has contributed to substantial increases in coverage of recording of food intake markers in Brazil. The higher APC values observed for recording markers using e-SUS APS appear to be mainly due to migration from one system to the other. In addition, it is important to consider the potential effect of the use of electronic health records software developed by local health departments or purchased from third parties on study estimates[34].

Studies show that factors such as overwork, difficulties incorporating data entry into primary care work routines, lack of training in data collection and entry, high rates of staff turnover, poor internet connection, and the length of the form used to enter the data into the system may explain the underuse of the system[32,36,37]. The wide range of other priority primary care actions, such as childcare and antenatal care, as well as follow-up of patients with chronic diseases, also tends to mean that FNS actions are given lower priority, despite the fact that diet is a fundamental factor for the care of individuals with these conditions[3,12].

These factors should be considered in the light of the historic underfunding of the SUS, with Brazil being the only country with a universal health care system in which health expenditure is lower than in the private system[38]. The present study shows a positive correlation between APC in population coverage of recording food intake markers and HDI and GDP per capita in some life stages, suggesting that increased investment could lead to an expansion of coverage of FNS actions related to food intake. In the state of Minas Gerais for example, evidence shows that the prioritization of other areas of health to the detriment of Sisvan and the underestimation of the physical infrastructure and human resources needed to operationalize the system contributed to low coverage rates[39].

This study has some limitations. The fact that we used secondary data from various sources means that the data is subject to collection, filling-in, and entry errors. Outdated census data may also have affected the denominators used in the calculations, which are dependent on the population estimates made by the IBGE[14]. Our analysis covers the period between 2015, the year in which the revised food intake markers were adopted, and 2019, the year before the COVID-19 pandemic. Although the use of a large number of points in time is beneficial for Prais-Winsten analysis[20], the use of 5-year periods in the present analysis provided valuable insights into FNS actions in Brazil. In addition, this study is the first work to assess population coverage of recording of food intake markers at national and regional level across all life stages after the integration of the two recording systems used in primary care services. Our findings show that organizational improvements and the qualification of health care professionals for FNS are essential to achieving food intake monitoring goals in Brazil. It is also important to highlight that existing data should be interpreted with caution when proposing the formulation of programs and research evaluation, paying special attention to the context in which the information on food intake markers was obtained and recorded.

It can be concluded that the population coverage of recording food intake markers in Brazil increased over the study period, reaching 0.92% of the total population in 2019. Coverage was higher among children aged up to 4 years in all regions. There was an upward temporal trend in data entry using e-SUS APS over the study period, to the detriment of Sisvan Web. With low coverage and evidence of a shift in use from Sisvan Web to e-SUS APS, the latter may be considered an important strategy for designing future measures to strengthen FNS actions in the country.

Collaborations

JMS Ricci: design, analysis and interpretation of data, and writing of the manuscript. ALZ Romito: analysis and interpretation of data. SA Silva: data interpretation and critical review of the manuscript. AAF Carioca: design, data interpretation, and critical review of the manuscript. BH Lourenço: conception and design, analysis supervision, data interpretation, and critical review of the manuscript. All authors approved the final version and are responsible for the manuscript.

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