

# Relationship between social indicators and food insecurity: a systematic review

## *Relação entre indicadores sociais e insegurança alimentar: uma revisão sistemática*

Juliana de Bem Lignani<sup>I</sup> , Poliana de Araujo Palmeira<sup>II</sup> ,  
Marina Maria Leite Antunes<sup>I</sup> , Rosana Salles-Costa<sup>I</sup> 

**ABSTRACT:** *Introduction:* The relationships between the social indicators (SIs) that determine food insecurity (FI) have not been described yet. This systematic review aims to identify which SIs are associated with FI in Brazilian households and how these relationships are explained. *Methods:* The research protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO — CRD42018106527). Three independent researchers performed the search in the Latin American and Caribbean Health Sciences Literature (LILACS) and National Library of Medicine (PubMed) databases (June/2018). The study included articles that used the Brazilian Household Food Insecurity Measurement Scale (*Escala Brasileira de Insegurança Alimentar* — EBIA) to assess FI and that evaluated the association between SIs and FI. *Results:* We included 18 articles in this review. The Kappa concordance index between the researchers was 0.72 (95%CI 0.42 – 1.00). Most articles were cross-sectional and used multivariate regression for the statistical analysis. At least one income-related SI had a significant association with FI, and, in most studies, they presented the highest values of association measures. We organized the authors' explanation about the relationships between SIs and FI in a conceptual model. The study identified three possible justifications for the association between SIs and FI: direct relationship, relationship mediated by income, or relationship mediated by another SI and income. *Conclusion:* Income assumed a central role in the mediation between several SIs and FI. However, the analysis methods of the studies did not allow us to investigate this mediation. Therefore, improving data analysis to isolate and understand the effect of SIs on FI is still necessary.

**Keywords:** Food and nutrition security. Food supply. Social indicators. Review.

<sup>I</sup>Universidade Federal do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

<sup>II</sup>Universidade Federal de Campina Grande – Cuité (PB), Brazil.

**Corresponding author:** Juliana de Bem Lignani. Universidade Federal do Rio de Janeiro Ringgold Standard Institution, Instituto de Nutrição Josué de Castro, Ilha do Fundão, Centro de Ciências da Saúde, Bloco J, 2º andar, CEP: 21941-901, Rio de Janeiro, RJ, Brazil. E-mail: julianablig@gmail.com

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**RESUMO: Introdução:** As relações existentes entre os indicadores sociais (IS) que determinam a insegurança alimentar (IA) ainda não foram descritas. Esta revisão sistemática se propõe a identificar os IS que se associam com a IA em domicílios brasileiros e como essa relação é explicada. **Metodologia:** O protocolo de pesquisa foi registrado no PROSPERO (CRD42018106527). A busca dos artigos foi realizada por três pesquisadoras independentes nas bases Lilacs e PubMed (junho/2018). O estudo incluiu artigos que utilizaram a Escala Brasileira de Insegurança Alimentar (EBIA) para avaliar a IA e que analisaram a associação entre IS e IA. **Resultados:** 18 artigos foram incluídos nessa revisão. O índice de concordância Kappa entre as pesquisadoras foi de 0,72 (IC95% 0,42 – 1,00). A maioria dos artigos foram do tipo transversais e utilizaram regressão multivariada para análise de dados. Pelo menos um IS relacionado à renda teve associação significativa com a IA e, na maioria dos estudos, eles foram os que apresentaram os maiores valores das medidas de associação. A justificativa dos autores sobre as relações entre IS e IA foram organizadas em um modelo conceitual. O estudo identificou 3 possibilidades de explicar a associação entre IS e IA: relação direta, relação mediada pela renda, ou por outro IS e renda. **Conclusão:** A renda assumiu um papel central na mediação de diversos IS com IA. Entretanto, os métodos de análise dos estudos não possibilitaram lidar com essa mediação, portanto aprimoramentos nas análises de dados são necessários para isolar e compreender o efeito dos IS na IA.

**Palavras-chave:** Segurança alimentar e nutricional. Abastecimento de alimentos. Indicadores sociais. Revisão.

## INTRODUCTION

The Brazilian Household Food Insecurity Measurement Scale (*Escala Brasileira de Insegurança Alimentar* — EBIA), validated in 2003<sup>1</sup>, enables us to measure the food stability and access dimensions in the household food insecurity (FI) diagnosis. EBIA is an instrument composed of 14 dichotomous (yes/no) items, including household information of the previous three months, elaborated based on the Household Food Security Survey Module (HFSSM)<sup>1,2</sup>. Each affirmative answer corresponds to one point. The final score is analyzed based on cut-off points that classify the households into four categories: food security, mild FI (concern about or no guarantee of access to sufficient quality food), moderate FI (lack of quality food for consumption or limited amount of food for adults), and severe FI (hunger or lack of food for adults and children)<sup>1,2</sup>. Two recent studies<sup>3,4</sup> evaluated the psychometric quality of EBIA and identified that the scale has well-defined categories, specifically those of major severity. This finding reinforces the use of EBIA as an instrument to determine household FI.

Internationally, the Food and Agriculture Organization of the United Nations (FAO) has been evaluating FI with the Food Insecurity Experience Scale (a scale similar to EBIA)<sup>5</sup>. The most recent FAO report informed that more than 700 million people experienced severe FI in the world in 2018<sup>5</sup>.

Since its validation, EBIA has been used as a household FI evaluation instrument in national surveys<sup>6-8</sup> and local studies. The most recent national survey showed that 22.6% of Brazilian households experienced some degree of FI<sup>8</sup>. Although this number seems large, it

underlines the decreasing trend in FI in Brazil since 2004<sup>8</sup>. Studies that investigated household FI in Brazil emphasized that this condition is related to social disparities<sup>9-11</sup>, reinforcing the evidence of the associations between the FI measured by EBIA and social indicators (SI). Identifying the life conditions associated with FI is fundamental to recognize its determinants.

In 2011, Kepple and Segall-Correa<sup>12</sup> proposed a conceptual model for the determinants of FI based on some SIs. However, we highlight that, in the conceptual model presented by the authors, some determinants may influence and/or be influenced by another determinant, especially at the household level.

Among the several studies that have found relationships between SIs and FI measured by EBIA, none has been identified if these SIs cause or influence each other. Consequently, the relationships between all SIs that determine FI have not been described. Such an analysis would be important to define the determinants of household FI, making it possible to focus on actions that are likely to reduce FI.

This systematic review aims to identify which SIs are associated with FI in Brazilian households and how these relationships are explained.

## METHODS

This systematic review protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) under the registration no. CRD42018106527. Three independent researchers performed the literature search in the Latin American and Caribbean Health Sciences Literature (LILACS) and National Library of Medicine (PubMed) databases. The terms searched in both databases were: “*food supply*” (MeSH terms); OR “*food insecurity*” (title); OR “*food security*” (title); OR “*household food insecurity*” (title, abstract); OR “*household food security*” (title, abstract); AND “*Brazil*” (title, abstract). Since EBIA was validated in 2003–2004, the search involved studies published between 2003 and June 2018 (final data search). We included studies published in Portuguese, English, or Spanish.

The inclusion criteria were:

- cross-sectional or observational cohort studies,
- studies conducted in the Brazilian population;
- studies that used EBIA to assess household FI;
- studies that evaluated the association between SIs and household FI.

We excluded literature reviews, experimental studies, qualitative studies, validation of questionnaires for investigation of household FI (or analyses of EBIA cut-off points or concordance between scales of household FI), studies whose main outcome was not household FI, and studies that used SIs only as sample descriptors and/or adjustment variables for the data analysis.

After the literature search, duplicate articles were excluded. The remaining works were evaluated according to the inclusion criteria based on the title and abstract. In the second

step, the articles were read in full to assess if the content met the exclusion criteria. The third step involved the quality assessment of the selected articles following the recommendation of the instrument Quality Assessment Tool For Quantitative Studies published by the research group of the Effective Public Health Practice Project<sup>13</sup>. We chose this instrument because its items are more appropriate for cross-sectional observational studies, which were the types of studies evaluated (except for one cohort study). In addition to the items present in this instrument, we included questions considered relevant when using EBIA to assess household FI, according to Pérez-Escamilla et al.<sup>1</sup>. These authors declare that:

- EBIA must be answered by the person responsible for the food in the household or, in their absence, by someone able to provide information about the subject;
- the household must be used as the research domain.

Three independent researchers selected the full articles. Two of them performed quality selection and data extraction, also independently. Any disagreements were resolved by consensus between the researchers. In the absence of consensus, a third evaluator with expertise on the issue was consulted. The agreement between the researchers was evaluated at all times by the kappa calculator. Concordance was determined when the two researchers chose to exclude or include the same article.

After defining which articles to include in this review, we reviewed the studies independently for data extraction. The information to be extracted was previously established. The data collected were year of publication, year of data collection, study population, statistical analysis method, categorization of the dependent variable (household FI), information about the SIs used as independent variables, their categories of analysis, and the significant associations with household FI (when the category of analysis was FI) or with moderate/severe household FI (when it was possible to select these categories). The justifications presented by the authors for the associations found between SIs and household FI were also extracted. In case of doubt, the authors were contacted for clarification; four authors replied with the requested information.

The flow diagram elaborated based on the PRISMA protocol<sup>14</sup> presents the steps for article selection (published as supplemental material). We found 275 original articles. We excluded 214 of them, 78 (28%) for being duplicates and 136 (46%) because they did not meet the inclusion criteria (literature reviews  $n = 5$ ; qualitative studies  $n = 19$ ; analysis of policies and/or national government programs — National Food and Nutrition Policy, National Food and Nutrition Security Policy, and National School Feeding Program —  $n = 17$ ; analyses of family farming and food production  $n = 35$ ; validations or psychometric analyses of FI scales or analyses of EBIA cut-off points  $n = 9$ ; articles on food safety  $n = 8$ ; articles on health or food consumption  $n = 29$ ; or articles that did not use EBIA as the household FI evaluation scale  $n = 9$ , did not evaluate SIs as independent variables  $n = 3$ , or did not perform a statistical analysis of the associations between SIs and household FI  $n = 2$ ). The remaining 61 studies were read in full.

In the next step, we excluded 36 studies because they did not use household FI as the main outcome; did not evaluate SIs or used them only as adjustment variables; or did not analyze the association between SIs and household FI. At the end of this step, 25 articles were evaluated according to quality criteria. Seven studies were excluded: 5 of them did not meet the quality criteria of the instrument Quality Assessment Tool for Quantitative Studies<sup>13</sup>, and 2 did not indicate if the EBIA respondent was the person responsible for the food in their household.

This study did not require ethical approval since it was based on secondary data analyses. This paper used the PRISMA guideline<sup>14</sup> to improve the reporting and did not receive any financial support.

## RESULTS

This review included 18 articles. The kappa concordance index between the researchers was 0.72 (95%CI 0.42 – 1.00), indicating moderate agreement<sup>15</sup>.

The articles were published between 2008 and 2018. Data were collected between 2004 and 2015. The articles selected consisted of cross-sectional studies and only one cohort study<sup>16</sup>. The samples used in the articles were local populations (from metropolitan and rural areas), data from national surveys carried out in global populations [National Household Survey (Pesquisa Nacional por Amostra de Domicílios — PNAD) and National Survey on Demography and Health (Pesquisa Nacional de Demografia e Saúde — PNDS)], and specific population groups (Quilombola Census).

As to data analysis (Table 1), 88.8% (n = 16) of the studies used multivariate regression models, including Poisson regression (n = 8), logistic regression (n = 6), multinomial logistic regression (n = 1), and log-binomial regression (n = 1). Only one of these studies<sup>17</sup> conducted a hierarchical analysis. Household FI was evaluated as the outcome in different ways. The study by Segall-Correa et al.<sup>18</sup> was the only one that used food security + mild FI as the category for the dependent variable. The other articles used one of the following combinations: mild FI + moderate FI + severe FI (n = 4)<sup>19-22</sup>; moderate FI+severe FI (n = 11)<sup>16,17,23-31</sup>; or severe FI (n = 2)<sup>32,33</sup>.

Household FI was associated with lower monthly per capita income; living in unfinished houses or houses with poor-quality construction material; a large number of residents per household or bedroom; a large number of residents under 18 years of age per household; lower educational level of the head of household; female, black and/or multiracial, older, unemployed, or informally employed head of household; living in urban areas or the North or Northeast regions; not having a refrigerator or other major household goods; participating in a conditional cash transfer program; worse socioeconomic classification; head of household living without a partner; untreated drinking water; being local (when the region had many migrants); being a descendant of black slaves (*quilombola*); living in houses with few rooms; and lack of public water supply, public sewer, or toilet at home (Table 1).

Table 1. General characteristics and main results of the studies included in the systematic review. 2018.

Studies (n)	Statistical measure	Social indicators associated with food insecurity/food security*	Measure (confidence intervals)*	
			2005	2011
General HHs. PB. <sup>16</sup> (406)	$\chi^2$ /proportion (%)	Improvement in HH income	39.5%	24.4%
		Continued to participate in a CCTP	61.5%	45.9%
		Stopped participating in a CCTP	41.5%	19.5%
		<i>Results from the 3<sup>rd</sup> level</i>	<i>2013**</i>	
General HHs (data from PNAD). Brazil <sup>17</sup> (2004 = 108,377; 2009 = 117,037; 2013 = 110,655)	Log-binomial regression / PR Hierarchical model	Having major HH goods	2.08 (1.99 – 2.17)	
		Head of HH with $\leq 4$ years of schooling	1.94 (1.86 – 2.01)	
		Living in the North/Northeast regions	1.81 (1.72 – 1.91)	
		Non-white head of HH	1.58 (1.52 – 1.65)	
		Head of HH aged < 60 years	1.52 (1.46 – 1.59)	
		> 2 residents/bedroom	1.45 (1.40 – 1.50)	
		Inadequate sanitation	1.41 (1.35 – 1.48)	
		Female head of HH	1.32 (1.28 – 1.37)	
		Unemployed head of HH	1.26 (1.20 – 1.31)	
		Living in a rural area	0.88 (0.83 – 0.93)	
		HHs with severe food insecurity (data from Census and PNAD). Brazil <sup>32</sup> (111,922)	MLR/OR	Per capita income < 1/4 MW <sup>b</sup>
Head of HH with < 1 year of schooling	4.76 (4.19 – 5.42)			
Living in Roraima	3.16 (2.06 – 4.83)			
Lack of public water supply	1.78 (1.59 – 1.99)			
Female head of HH	1.60 (1.50 – 1.71)			
$\geq 3$ residents aged < 10 years/HH	1.57 (1.42 – 1.74)			
Black and/or multiracial head of HH	1.49 (1.39 – 1.61)			
No. of residents/HH	0.93 (-)			
Living in a rural area	0.50 (0.44 – 0.58)			
HHs covered by ESF. PI <sup>23</sup> (323)	MLR/OR	Participating in a CCTP	4.10 (1.13 – 14.90)	
		$\leq 5$ rooms/HH	3.65 (1.31 – 10.15)	
		Per capita income < 1/2 MW <sup>g</sup>	3.52 (1.02 – 12.74)	
		Unfinished house	0.34 (0.16 – 0.72)	
		Female head of HH	0.14 (0.04–0.56)	

Continue...

Table 1. Continuation.

Studies (n)	Statistical measure	Social indicators associated with food insecurity/food security*	Measure (confidence intervals)*
HHs with children/adolescents attending public school. BA <sup>24</sup> (1,101)	MLR/OR	Per capita income $\leq \frac{1}{4}$ MW <sup>d</sup>	2.63 (1.68 – 4.08)
General HHs. AL. <sup>25</sup> (1,444)	MPR/PR	Untreated drinking water	2.64 (1.47 – 4.74)
		Head of HH with $\leq 4$ years of schooling	1.63 (1.30 – 2.05)
		$\leq 4$ rooms/HH	1.38 (1.16 – 1.65)
		Participating in a CCTP	1.33 (1.11 – 1.59)
		$\geq 4$ residents/HH	1.27 (1.08 – 1.50)
		Female head of HH	1.25 (1.06 – 1.47)
		Maternal schooling $\leq 4$ years	1.21 (1.01 – 1.46)
Lower socioeconomic HHs. SP <sup>26</sup> (691)	MMLR/OR	Head of HH informally employed	4.51 (1.51 – 13.4)
		Participating in a CCTP	3.33 (1.22 – 9.09)
		Unfinished house	3.20 (1.38 – 7.39)
		Increase by 1 HH good	0.86 (0.80 – 0.92)
HHs participating in CCTP (data from PNAD). Brazil <sup>18</sup> (112,716)	MLR/OR	$\geq 1$ resident aged $< 18$ years/HH	1.91 (1.09 – 3.35)
		Male head of HH	1.64 (1.31 – 2.04)
		Head of HH with $\geq 4$ years of schooling	1.43 (1.22 – 1.68)
		White head of HH	1.39 (1.16 – 1.64)
		$\leq 5$ residents/HH	1.36 (1.18 – 1.62)
		$\leq 2$ residents/room	1.33 (1.18 – 1.49)
		Living in a non-metropolitan area	1.22 (1.07 – 1.40)
		Increase in income by US\$ 3.67 <sup>a</sup>	1.08 (1.04 – 1.12)
Quilombola HHs (data from Census Quilombola). Brazil <sup>27</sup> (8,856)	MLR/OR	Living in the North region	11.26 (7.83 – 16.19)
		$\geq 8$ residents/HH	3.52 (2.90 – 4.26)
		Per capita income $< \text{US\$ } 44^f$	2.78 (2.36 – 3.29)
		Head of HH with $\leq 4$ years of schooling	1.92 (1.29 – 2.85)
		Lack of public sewer	1.88 (1.61 – 2.19)
		Lack of public water supply	1.23 (1.10 – 1.39)
		Not participating in a CCTP	0.66 (0.58 – 0.75)

Continue...

Table 1. Continuation.

Studies (n)	Statistical measure	Social indicators associated with food insecurity/food security*	Measure (confidence intervals)*
HHs with children covered by ESF. NE and S <sup>28</sup> (NE = 5,419 / S = 5,081)	MPR/PR	<i>Results from the Northeast region:</i>	
		Per capita income ≤ US\$ 40.98 <sup>e</sup>	8.38 (5.87 – 11.96)
		Black mother	1.50 (1.18 – 1.90)
		Maternal schooling ≤ 4 years	1.43 (1.23 – 1.66)
		Female head of HH	1.32 (1.18 – 1.47)
		≥ 3 residents aged < 7 year/HH	1.28 (1.08 – 1.51)
		Participating in a CCTP	1.26 (1.11 – 1.42)
		<i>Results from the South region:</i>	
		Per capita income US\$ 40.98–61.47 <sup>e</sup>	8.10 (5.36 – 12.25)
		Maternal schooling ≤ 4 years	1.87 (1.36 – 2.58)
		Participating in a CCTP	1.48 (1.17 – 1.87)
		Female head of HH	1.42 (1.12 – 1.80)
		Multiracial mother	1.37 (1.11 – 1.70)
HHs with children attending public school. PB <sup>29</sup> (793)	MPR/PR	Untreated drinking water	1.65 (1.26 – 2.17)
		Not having a refrigerator	1.54 (1.13 – 2.09)
		≥ 6 residents/HH	1.24 (1.04 – 1.64)
		Lack of toilet in the house	1.21 (1.09 – 1.63)
HHs participating in CCTP with children. MG <sup>19</sup> (243)	BPR/PR	Maternal schooling < 7 years	1.86 (1.52 – 2.83)
HHs with children/adolescents. RJ <sup>33</sup> (1,085)	PR/PR	> 8 residents/HH	6.18 (1.31 – 11.06)
Low HH income PB <sup>20</sup> (4,533)	MLR/OR	Per capita income ≤ US\$ 10.64 <sup>e</sup>	19.10 (11.75 – 31.04)
		Unfinished house	1.98 (1.64 – 2.38)
		Lack of public water supply	1.38 (1.15 – 1.65)
HHs with children (data from PNDS). Brazil <sup>30</sup> (3,923)	MPR/PR	Living in the N/NE regions	1.9 (1.7 – 2.2)
		Maternal schooling ≤ 8 years	1.9 (1.5 – 2.3)
		Socioeconomic classification D/E	1.8 (1.6 – 2.1)

Continue...



Table 1. Continuation.

Studies (n)	Statistical measure	Social indicators associated with food insecurity/food security*	Measure (confidence intervals)*
HHs with children (data from PNDS). Brazil <sup>30</sup> (3,923)	MPR/PR	Participating in a CCTP	1.4 (1.2 – 1.6)
		≥ 3 residents in preschool age/HH	1.4 (1.2 – 1.7)
		House with poor-quality construction materials	1.3 (1.1 – 1.4)
		Female head of HH without a partner	1.3 (1.1 – 1.5)
		Living in a rural area	0.8 (0.7 – 0.9)
		Female head of HH	2.21 (1.47 – 3.31)
		No. of residents/bedroom ≥ 3	1.91 (1.23 – 2.96)
		Living in inadequate conditions	1.84 (1.12 – 2.08)
		Head of HH with ≤ 4 years of schooling	1.68 (1.00 – 2.81)
HHs with adolescents. MT <sup>31</sup> (363)	MPR/PR	Monthly income ≤ ½ MW <sup>d</sup>	5.60 (2.36 – 13.27)
		Black adolescent	2.37 (1.48 – 3.80)
		Untreated drinking water	2.08 (1.48 – 2.94)
		Head of HH born in the city	1.69 (1.13 – 2.51)
HHs covered by NASF. GO <sup>21</sup> (356)	MPR/PR	Socioeconomic classification D/E	2.2 (1.3 – 3.2)
		Unfinished house	1.3 (1.0 – 1.5)
		Not participating in a CCTP	1.3 (1.1 – 1.6)
		≥ 5 residents/HH	1.3 (1.1 – 1.6)
General HHs BA. <sup>22</sup> (459)	MPR/PR	Socioeconomic classification E	3.22 (1.95 – 5.32)
		Participating in a CCTP	1.52 (1.25 – 1.84)
		Being a <i>quilombola</i>	1.25 (1.06 – 1.47)
		≥ 4 residents/HH	1.20 (1.01 – 1.43)

\*Data presented in descending order; \*\*data presented correspond only to 2013; HH: household; CCTP: conditional cash transfer program; PNAD: Pesquisa Nacional por Amostra de Domicílios: National HH Survey; MLR: multivariate logistic regression; OR: *odds ratio*; MW: minimum wage; PR: prevalence *ratio*; PNDS: Pesquisa Nacional de Demografia e Saúde: National Survey on Demography and Health; MPR: multivariate Poisson regression; ESF: Estratégia Saúde da Família: Family Health Strategy; *Quilombola*: descendant of black slaves; BPR: bivariate Poisson regression; NASF: Núcleo de Apoio à Saúde da Família: Family Health Support Program; MMLR: multivariate multinomial logistic regression; PB: Paraíba; RJ: Rio de Janeiro; BA: Bahia; MT: Mato Grosso; AL: Alagoas; MG: Minas Gerais; GO: Goiás; SP: São Paulo; PI: Piauí; N: North; NE: Northeast; S: South. <sup>a</sup>2004: US\$ 1 = R\$ 2.72<sup>37</sup>; <sup>b</sup>2004: MW = US\$ 96.56<sup>37,38</sup>; <sup>c</sup>2005: US\$ 1 = R\$ 2.35<sup>37</sup>; <sup>d</sup>2007: US\$ 1 = R\$ 2.12<sup>37</sup>/MW = US\$ 210.74<sup>38</sup>; <sup>e</sup>2010: US\$ 1 = R\$ 1.71<sup>37</sup>; <sup>f</sup>2011: US\$ 1 = R\$ 1.67<sup>37</sup>; <sup>g</sup>2012: US\$ 1 = R\$ 1.70<sup>37</sup>/MW = US\$ 301.58<sup>38</sup>.

The discussions of the studies were analyzed to identify how the authors explained the relationships found between SIs and FI. We organized these explanations in a conceptual model (Figure 1) to help visualize the relationships and systematize the associations. Figure 1

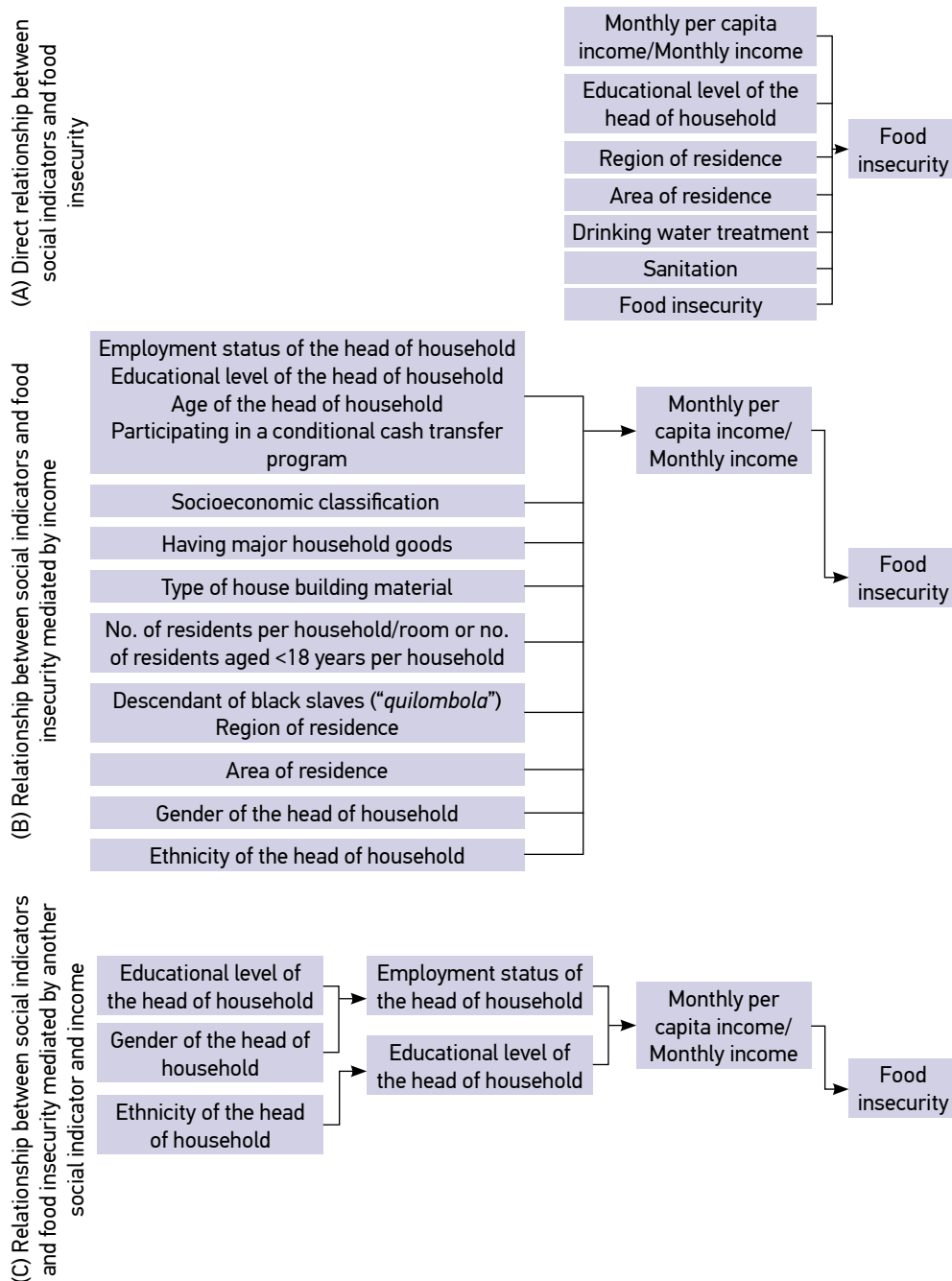


Figure 1. Conceptual model of the relationships between social indicators and food insecurity. Systematic review. 2018.

shows three possibilities to justify the way SIs and household FI are associated: (A) direct relationship between SIs and FI, (B) relationship between SIs and FI mediated by income, and (C) relationship between SIs and FI mediated by another social indicator and income. Based on Figure 1, income had a central role in the associations with FI.

Table 1 shows that, in 16 articles (88.9%), at least one income-related SI (monthly income/per capita income, participating in a conditional cash transfer program, socioeconomic classification, and/or not having major household goods) had a significant association with FI. In most of these studies (66.7%,  $n = 12$ ), these SIs presented the strongest correlations. Thus, income-related SIs were the main determinants of FI. The role of income as a mediator in the association between SIs and FI (as presented in Figure 1) may explain this result. It is important to consider whether the mediation role played by income increases the strength of its association with FI.

## DISCUSSION

The use of EBIA in population studies enables researchers to identify households where the quality and quantity of food consumed among the residents is compromised<sup>1</sup>, allowing us to verify relationships with social inequalities in the country. In the last 15 years, the identification of SIs related to FI has contributed to defining the characteristics of households experiencing difficulties in accessing food of sufficient quality and quantity<sup>5</sup>. Studies on the subject have highlighted that FI measured by EBIA correlates with unfavorable social conditions, represented by SIs. Since these indicators are used to evaluate adverse living conditions, as well as to characterize poverty<sup>34</sup>, their use in studies that analyze FI is necessary for identifying possible knowledge areas linked to FI.

The studies included in this review show how FI measured by EBIA, especially in its most alarming forms (moderate and severe FI), can reach a range of social inequalities. It was also possible to identify income as a convergence point for the relationship between several SIs and FI.

Regarding the direct relationship, the studies by Gubert et al.<sup>32</sup>, Cabral et al.<sup>16</sup>, and Sabóia e Santos<sup>23</sup> revealed that lower incomes compromise the acquisition of food of sufficient quality and quantity. The lower educational level of the head of household has an impact on FI since it can affect the financial administration and maintenance of adequate food intake, including the choice of quality food<sup>24-26</sup>. In turn, untreated drinking water and the lack of public water supply (also included in sanitation) compromises the access to water, an essential food<sup>25</sup>. The studies by Segall-Correa et al.<sup>18</sup>, Gubert et al.<sup>27</sup>, and Santos et al.<sup>17</sup> reported that households located in urban areas and the North/Northeast regions had worse living conditions, higher expenditure on non-food items, and greater difficulties in accessing food not produced in those respective areas.

The area of residence (urban/rural) presents a dual consideration, since both areas can have a direct relationship with FI or food security. In some studies, rural areas are a protective

factor against FI due to the greater possibility of food production for family consumption and lower expenses on transportation, clothing, and others<sup>32,18</sup>. In other articles, families living in rural areas had a higher risk of FI because they did not have direct access to food, nor the possibility of comparing prices in different grocery stores<sup>27</sup>.

We underline that among the SIs with association explained by income, the direction was always inverse. Namely, the worse the SI level, the lower the household income, and, consequently, the greater the household FI<sup>18,24-29,34</sup>.

For the SIs explained by the mediation of another SI and income, the relationship between them and FI was initially mediated either by the employment status or the educational level of the head of household, which would correlate with lower income and could, in turn, justify the FI. When the head of household had a lower educational level or was female, they were more likely to have a lower employment status or worse working conditions, leading to lower family income<sup>19,23,24,26,27,32</sup>. Similarly, black or multiracial heads of households tended to have a lower educational level<sup>32,27</sup>, and, consequently, these households had a lower family income.

All relationships presented as explanations for the associations of SIs with household FI reported by the authors of the articles included in this review can be found in national surveys<sup>35,36</sup>. Some SIs had a relationship with FI that was explained in more than one way. Therefore, we emphasize the need to elaborate a theoretical conceptual model indicating which relationships are more appropriate for analyses whose outcome is FI.

This review also detected that the analyses published to date are not enough to understand the SI effects on the causality of FI. We suggest the use of new analysis models to improve the understanding of the causal relationships between SIs and household FI and clearly identify the determinants of FI.

Despite the methodological rigor in the search for articles that support the analysis of the association between SIs and household FI, the present study has some limitations. The option of restricting the analysis to studies that used EBIA to identify household FI may interfere with the SIs associated with FI, besides limiting the evaluations to investigations conducted in Brazil. However, as EBIA is a valid instrument for the household domain<sup>1,4</sup> and used in national surveys and many local studies<sup>8</sup>, we decided to adopt it to detect household FI in this review. We also opted not to perform a meta-analysis because our objective was to identify the SIs related to household FI and not to find the impact of SIs on household FI.

## CONCLUSION

The SIs associated with FI measured by EBIA also characterize the family's poverty. Therefore, this review demonstrated relationships between adverse social conditions and FI. We could also identify that, while some SIs were directly related to FI, others presented relationships mediated by income and/or another SI. Income assumed a central role in the

mediation between several SIs and FI. However, the analysis methods of the studies included in this review did not allow us to investigate this mediation.

In this context, although the present systematic review has detected the causality generated by determinants of household FI, we need to improve data analysis to isolate the effect of each SI on FI of Brazilian families, and, consequently, understand the relationships between them. Thus, household FI measured by EBIA is a broad and consistent social vulnerability index.

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