

Ciência & Saúde Coletiva



This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited. Fonte: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232015000702105&lng=en&nrm=iso&tlng=pt&ORIGINALLANG=pt. Acesso em: 6 abr. 2018.

REFERÊNCIA

SCHUMANN, Lívia Rejane Miguel Amaral; MOURA, Leides Baroso Azevedo. Vulnerability synthetic indices: a literature integrative review. **Ciência & Saúde Coletiva**, Rio de Janeiro, v. 20, n. 7, p. 2105-2120, jul. 2015. Disponível em: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232015000702105&lng=en&nrm=iso>. Acesso em: 6 abr. 2018. doi: <http://dx.doi.org/10.1590/1413-81232015207.10742014>.

Vulnerability synthetic indices: a literature integrative review

Lívia Rejane Miguel Amaral Schumann ¹

Leides Baroso Azevedo Moura ²

Abstract *The concept of vulnerability is delimited by dynamic social and multigenerational processes involving at least three dimensions: exposure to risk trajectories, internal and external capabilities of reaction and possibilities of adaptation based on both the intensity of risk and the resilience of people. In order to identify and describe the synthetic indices of vulnerability, there was an integrative literature review. We consulted free access articles indexed in the following databases: BioMed, Bireme, PubMed, Reldalyc, SciELO and Web of Science; and we used controlled descriptors in English and Portuguese for all time slots available with selection and analysis of 47 studies that reported results of 23 synthetic indices of vulnerability. The results showed that the synthetic indices of vulnerability address four themes: social determinants of health; environmental and climatic conditions; family and course of life; territories and specific geographic areas. It was concluded that the definition of the components and indicators, as well as the methodologies adopted for the construction of synthetic indices need to be evaluated by means of the limitations and advantages of reporting the vulnerability through summary measures in policy formulation and decision-making aimed at human development.*

Keywords *Vulnerability Analysis, Risk*

¹ Centro de Estudos Avançados Multidisciplinares, Universidade de Brasília (UnB). Campus Universitário Darcy Ribeiro ICC Sul módulo 8/ subsolo, Asa Norte. 70910-900 Brasília DF Brasil. liviarejane.amaral@gmail.com

² Programa de Pós-Graduação em Desenvolvimento Sociedade e Cooperação Internacional, UnB.

Introduction

In recent decades, the term vulnerability has been used in studies expressing the multidimensionality of a concept under construction that is employed in several fields of knowledge and can highlight areas such as natural and social life sciences, especially in the area of geography, demography, economy, health and bioethics. The diversity of disciplinary approaches and the polysemy definition provide a wide use of the term vulnerability, which acquires specific boundaries depending on the area in which it is used, but risks losing meaning by its indiscriminate use in a broad spectrum of approaches without a theoretical and conceptual delimitation.

Concerning the different forms of usage of the term vulnerability, Gallopín¹ states that this plurality of definitions possibly occurs due to the different needs of disciplinary fields and it may be a reflection of the different intellectual traditions, which ultimately does not produce implementation and communication interfaces in all disciplines.

Synthetic indicators are measures-syntheses used to understand a particular social reality or dimensions of the social world and can be applied in relation to population development dynamics, spaces and environments. According to Neto et al.², these measures came to have greater expression in Brazil during the 90s, a time when several indicators have emerged in the country in order to understand the social reality through a single measure, achieved by the combination of multiple quantifiable analytical measurements of their dimensions. Increasingly, indicators of social welfare, such as the Human Development Index (HDI) developed by the United Nations Development Program, are now used by researchers and public administrators. Jannuzzi³ lists a group of synthetic indicators, not necessarily involved with the issue of vulnerability, but which were developed in Brazil by researchers from universities, government agencies and research centers; they are: i) Municipal Human Development Index (HDI) and Municipal Life Conditions Index (LCI), of the João Pinheiro Foundation, MG; ii) Municipal Quality Index - green, Municipal Quality Index - needs, Municipal Quality Index - housing needs and Municipal Quality Index - fiscal sustainability, of the CIDE/RJ Foundation; iii) Paulista Social Responsibility Index (PSRI), Youth Vulnerability Index (YVI) and Paulista Social Vulnerability Index (PSVI), of the SEADE/SP Foundation; iv) Expanded Municipal Social

Index (EMSI), of the Economics and Statistics Foundation, RS; v) Social Development Index (SDI) and Economic Development Index (EDI), of the Superintendence of Economic and Social Studies of Bahia (SEI/BA); vi) Urban Life Quality Index (ULQI) and Social Vulnerability Index (SVI), of the Municipality of Belo Horizonte/PUC Minas/MG; and vii) Municipal Indicator of Educational Development (MIED) of INEP, Cedeplar and NEPO.

These instruments are presented as facilitators to meet the information demands for policy-making, for decision-making in public spheres, for dissemination of the synthetic results by the media, as well as the dissemination of the culture of indicators' use in the agreements of the agendas of national and global public policies.

Considering the boost given to the construction of synthetic indicators, the question posted by Neto et al.² expresses the possibility of extending the use of these tools: if the HDI, synthesizing only three dimensions of social reality, seems to be an indisputable measure to monitor the social progress of countries in the eyes of great part of the media and managers - or rather, human development in the countries - and work as an instrument to mark the distribution of international aid resources, why not develop a composite indicator of a larger set of proxies of the social world and enhance its use as a broader assessment tool of public action and as a global allocation criterion of the public spending in the country?²

However, despite the increased use of synthetic indicators, some researchers have doubts in terms of the potential of these quantitative measurement instruments and situations and moments of decision-making within the cycle of public policies in which they should be applied. While some researchers consider it easier to make a decision using a measurement-synthesis than considering a wide range of indicators that may not point priorities², there are those who believe that a system of synthetic indicators would be more useful for establishing diagnoses and intervention plans².

This study aims to describe, in national and international literature, the proposed synthetic indicators involved with the issue of vulnerability.

Methodology

The integrative review was guided by the question "What are the indicators of vulnerability re-

lated to social issues presented in scientific studies and how they are built?" Using the keywords "vulnerability indicator", "Vulnerability Index" and "Vulnerability Analysis", on April 1, 2014, the articles available in international and national literature indexed in the following databases were consulted: BioMed, Bireme, PubMed, Redalyc, SciELO and Web of Science.

Each database has its access capabilities. Therefore, it was necessary to adopt a strategic search for the articles according to the specificity of each database. For inclusion criteria only access free articles written in Portuguese and English were considered.

When selecting data 212 articles were found. This number was reduced to 47 after deleting 77 repeated articles, excluding 80 articles that did not mention or only briefly mentioned a synthetic indicator of vulnerability without describing it as well as 8 articles that did not meet the inclusion criteria. The details of the selection process of the articles are shown in Table 1 according to each database.

Results

A total of 47 articles were selected and 23 synthetic indices were identified; they are: i) Environmental Vulnerability Index (EVI)⁴ - Zanella et al., 2013; ii) Vulnerability Index of Families from Paraná (IFPR)⁵ - Secretariat of State for Family and Social Development of Paraná (SEDS)/Paraná Institute for Economic and Social Development (IPARDES), 2012; iii) Social Vulnerability Index (SVI)⁶ - Huang and London, 2012; iv)

Municipal Vulnerability Index (MVI)⁷ - Fiocruz, 2011; v) Family Vulnerability Index to Disability and Dependency (IVF-ID)^{8,9} - Amendola et al., 2011; vi) Social and Environmental Vulnerability Index (SEVI)^{7,10} - Almeida, 2010; vii) Social Vulnerability Index (SVI)¹¹ - Amazônia - Ministry of Environment/German Technical Cooperation (GTZ), 2010; viii) Heat Vulnerability Index (HIV)^{12,13} - Reid et al, 2009; ix) Youth Vulnerability Index to Violence (YVI-Violence)^{14,15} - Brazilian Forum on Public Safety/SEADE Foundation, 2009; x) Social Vulnerability Index (SVI)¹⁶ - Andrew et al., 2008; xi) Social Vulnerability Index (SVI)¹⁷ - Fekete, 2008; xii) Family Social Vulnerability Index (FSVI)^{18,19} - Municipal Government of Curitiba/Institute of Urban Research and Planning of Curitiba (IPPUC)/Social Action Foundation (FAZ), 2008; xiii) General Vulnerability Index (GVI)²⁰ - Ministry of Science and Technology (MCT)/Fiocruz, 2007; xiv) Family Development Index (FDI)²¹ - Barros et al./IPEA, 2003; xv) Social Vulnerability Index of Children and Adolescents of the Greater Porto Alegre (SVI - IJ)²² - Municipal Government of Porto Alegre, 2003; xvi) Youth Development Index (YDI)^{23,24} - Unesco, 2003; xvii) Social Vulnerability Index (SoVI) 7,25,26 - Cutter et al., 2003; xviii) Youth Vulnerability Index (YVI)^{27,28} - Seade Foundation, SP, 2002; xix) Social Vulnerability Index of São Paulo (SVI-SP)^{7,10,29-35} - Seade Foundation, SP, 2000; xx) Social Vulnerability Index of Amazonas (SVI-AM)³⁶ - State Secretariat for Economic Planning and Development, 2000; xxi) Social Vulnerability Index (SVI)³⁷⁻⁴⁵ - Municipal Government of Belo Horizonte/PUC Minas, 1999; xii) Chronic Vulnerability Index (CVI)⁴⁶ -

Table 1. Details of the selection of items according to databases.

Databases	Articles found	Excluded articles			Articles analyzed
		Repetition	Failure to submit a vulnerability index	Incompatibility of filter selection for articles	
Biomed	23	0	16	2	5
Bireme	41	12	10	0	19
PubMed	50	25	23	2	0
Redalyc	37	3	16	1	17
Scielo	24	14	6	0	4
Web of Science	37	23	9	3	2
Total	212	77	80	8	47

Source: Elaborated by the authors.

Early Warning Working Group, 1999; and xxiii) Health Vulnerability Index (HVI)⁴⁷⁻⁵² - Municipal Health Department of Belo Horizonte, 1998.

Predominantly, the articles presented a quantitative approach through the use of statistical techniques. The studies examined both the primary data collected through field research, and secondary data from bases such as IBGE, SIM, Sinasc and municipal governments.

Regarding the origin of publications, most of the studies were published in Brazilian magazines and presented analyzes obtained in the Brazilian territory. However, we have also identified Brazilian articles in international journals and researches on the vulnerability of processes found in other countries such as Canada, USA, Ethiopia, Germany and Romania.

Charts 1 to 4 show the total number of selected indexes classified into four thematic categories depending on their prevailing approach: synthetic indices of vulnerability from the perspective of social determinants of health; social and environmental and climatic conditions; family and the life course; and a territory and specific geographic areas.

Discussion

In relation to the thematic categorization of synthetic indices described in the literature, as proposed in this article, it is important to mention that some of the areas present a certain level of overlap. All identified indexes treated, to some extent, the factors related to quality of life, the social determinants of life and interaction with the environment. The thematic division presented was based on the specific focus adopted, but it is not intended to limit the potential application for the other areas and it is recognized that the population, space, territory and territoriality are inseparable dimensions.

The vulnerability from the perspective of social determinants of health was represented by two indices, the HVI and the SVI. The HVI aimed to describe the sensitivity of the community to the challenges of health and resources to mitigate the negative health impacts caused by environmental risks. Among the variables discussed in this index we observed: location of health facilities, poverty rate, education, linguistic isolation, race/ethnicity and age. As a data source, researchers used the Cal-Atlas website to get the information from places with facilities for health care. And, for the calculation of the indicators, we

considered the data of persons in a radius of one mile of the health unit.

The SVI is a composite indicator that analyzes the characteristics of population groups living in census tracts through socioeconomic and sanitation variables. Based on the Census data, the index evaluated the percentage of permanent households with water supply, sewage and destination of inadequate or absent garbage; the ratio of household members; the percentage of illiterate persons; the percentage of private households with per capita income up to ½ a minimum wage; the average monthly nominal income of the persons responsible; and the percentage of people of different races or mixed skin color, black or indigenous.

The HVI was used in many studies as a tool for the identification of people who are in vulnerable processes. We analyzed various population groups, such as people who contracted dengue⁴⁷, elderly⁴⁸, people with functional limitations⁴⁹, people who are overweight or have obesity problems⁵⁰, and cases of perinatal mortality⁵¹.

The vulnerability under the social and environmental approach and climatic conditions was composed of five indices. The SVI, SEVI and HVI indexes emphasize the social and environmental conditions. After the construction of SEVI and SVI the spatial distribution of the values found was made to form the social and environmental maps. The crossing of these two maps and the values of each index through a matrix allowed a better understanding of the situation of a particular locality.

In relation to climate conditions we present the MVI and the GVI. The MVI is the result of the aggregation of two other indices: the CCI and the GVI. The CCI addresses the projected climate anomalies and the GVI, which differs from the second index of this dimension, is made up of health, environmental, social and family components. However the GVI, of the Ministry of Science and Technology (MST) and Oswaldo Cruz Foundation (Fiocruz), aggregates by means of arithmetical average the results of three other indices: socioeconomic (SEVI), epidemiological (EVI) and the climatological (CVI). Thus, we understand that the GVI is a composite index that combines different variables and assigns to each place a comparative measure regarding its vulnerability to climate changes anticipated in the coming decades²⁰.

The vulnerability under the family perspective and course of life was represented by nine indices, IVFPR, FVI-ID, YVI-Violence, FSVI, HVI, FDI, HVI - IJ, YDI and YVI.

Chart 1. Vulnerability synthetic indices under the perspective of the Social Determinants of Health.

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Vulnerability synthetic indices under the perspective of the Social Determinants of Health	Social Vulnerability Index (SVI)	Huang and London ⁶	<ul style="list-style-type: none"> • % of the area occupied by the blocks that are 1 mile distant of the health services; • % of the population in poverty; • % of people over 25 years without a high school diploma; • % of families considered linguistically isolated (situation which occurs when the family does not have a member over 14 years of age who speaks fluent English); • % of colored people (except non-Hispanic whites); • % of the population under 5 years or over 60 of age. 	2012
	Health Vulnerability Index (HVS)	Municipal Secretariat of Health of Belo Horizonte ³⁵⁻³⁷	<p>> Sanitation:</p> <ul style="list-style-type: none"> • % of permanent households with inadequate or no water supply; • % of permanent households with inadequate or no sanitation; • % of permanent households with inappropriate or no waste destination. <p>> Socioeconomic:</p> <ul style="list-style-type: none"> • Ratio of residents per household; • % of illiterate persons; • % of private households with per capita income up to ½ minimum wage; • Average nominal monthly income of responsible individuals; • % of people of mixed race / color, black or indigenous. 	1998

Source: Elaborated by the authors.

Analyzing the four measures directed to the family, the concern of researchers in terms of not limiting the vulnerability assessment to income analysis is noticeable. The FVI-PR is represented by 19 component indicators, divided into four dimensions: adequacy of the home; profile and composition of the family; access to work and income; and schooling conditions. The FDI was built based on six aspects: e) lack of vulnerability; ii) access to knowledge; iii) access to work; iv) availability of resources; v) child development; and vi) housing conditions. The FDI-ID, which is an adaptation of the FDI, has added two other dimensions: social relationships and health condition. And FSVI portrays the char-

acteristics of the home, education, occupation, income per capita and the number of children, adolescents and elderly.

The other indices of this theme category are directed to two specific population groups; four check the children's vulnerability condition; and one analyzes the situation of the elderly. For the first group we may highlight the YVI-Violence, the HVI - IJ, the YDI and YVI. For the group of elderly we have the HVI.

Among the main indicators associated with the children's group we have the homicide mortality rate of the male population between 15 and 19 years; death rate from accidents; participation of adolescent mothers aged 14 to 17 in the total

Chart 2. Vulnerability synthetic indices under a socioenvironmental perspective and climatic conditions.

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Vulnerability of synthetic indices under the socioenvironmental perspective and climatic conditions	Environmental Vulnerability Index (EVI)	Zanella et al. ⁴	<p>> Synthetic Index of Social Vulnerability:</p> <ul style="list-style-type: none"> • Education: Women who are responsible and illiterate; Women who are responsible and uneducated or with up to three years of study; Literate men who are responsible for permanent private households; Men who are responsible for permanent private households with no education or with up to 3 years of study. • Income: Women who are responsible without an income or with monthly income of up to 2 minimum wages; Men who are responsible for permanent private households with no income and nominal monthly income of up to 2 minimum wages. • Housing quality: Permanent private housing units that do not have mains water supply, wells or springs on the property and plumbing in at least one room; Private households that do not have bathrooms or toilets connected to sewer or septic tank; Permanent households where there is no garbage collection by the cleaning services or bucket and no destination for garbage disposal. <p>> Environmental Vulnerability Index:</p> <ul style="list-style-type: none"> • Geology • Geomorphology • Pedology • Vegetation Cover • Quality of urban infrastructure 	2013
	Municipal Vulnerability Index (MVI)	Fiocruz ⁷	<p>General Vulnerability Index:</p> <p>> Health Vulnerability Index:</p> <ul style="list-style-type: none"> • Morbidity: Dengue, Leptospirosis and American Cutaneous Leishmaniasis • Mortality from diarrhea in children under 5 years <p>> Social Vulnerability Index of the Family:</p> <ul style="list-style-type: none"> • Family Structure • Access to Knowledge • Access to Work • Availability of resources (income) • Children and Youth Development • Housing Conditions <p>> Environmental Vulnerability Index:</p> <ul style="list-style-type: none"> • Native vegetation cover and regeneration • Biodiversity Conservation • Occurrence of extreme hydrometeorological events and victims • Coastal Area 	2011

it continues

Chart 2. continuation

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Vulnerability of synthetic indices under the socioenvironmental perspective and climatic conditions	Social and Environmental Vulnerability Index (SEVI)	Almeida ¹⁰	<ul style="list-style-type: none"> > Social Vulnerability Index: <ul style="list-style-type: none"> • Education; • Infrastructure and housing; • Presence of the elderly; and • Presence of young people. > Physical-Spatial Vulnerability Index to Floods: <ul style="list-style-type: none"> • Frequency of flooding events. 	2010
	Heat Vulnerability Index (HVI)	Reid et al. ^{12,13}	<ul style="list-style-type: none"> • % of the population below the poverty line; • % of the population that has not completed high school; • % of the population of different color other than white; • % of the population living alone; • % of the population 65 years of age or older; • % of the population aged 65 and over who live alone; • % of the census tract area not covered by vegetation; • % of the population diagnosed with diabetes; • % of the family without air conditioning; • % of family with no air conditioning. 	2009
	General Vulnerability Index (GVI)	Ministry of Science and Technology (MCT)/ Fiocruz ²⁰	<p>Socioeconomic vulnerability index (SVI):</p> <ul style="list-style-type: none"> • Demographics: population density (inhabitants/ km²) and level of urbanization (%); • Income: households with more than 2 persons per room (%) and population with per capita income up to ½ the minimum wage (%); • Education: population aged 15 years and over with schooling below 4 years of education (%) • Sanitation: water supply (% of households), sewage (% of households) and garbage disposal (% of households); • Health: Infant mortality rate (%), life expectancy at birth (years) and health plans (% of total population with coverage). <p>Epidemiological vulnerability index (EVI):</p> <ul style="list-style-type: none"> • Incidence rate; • Ratio between the number of hospitalizations in the city and number of hospitalizations in the micro region; • Ratio between the number of deaths in the city and the number of deaths in the micro region; • Ratio between the total cost of hospitalization (R\$) in the city and the total cost of hospitalization (R\$) in the micro region. <p>Climate Vulnerability Index (CVI):</p> <ul style="list-style-type: none"> • Percentage of months of extreme precipitation, higher or lower than average. 	2007

Source: Elaborated by the authors.

Chart 3. Vulnerability synthetic indices from the perspective of the family and the life course.

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Synthetic indices of vulnerability from the perspective of the family and the life course	Vulnerability Index of Paraná Families (VIPRF)	State Secretariat for the Family and Social Development of Paraná (SEDS) / Paraná Institute for Economic and Social Development (IPARDES) ⁵	<ul style="list-style-type: none"> > Household Suitability: <ul style="list-style-type: none"> • Type of dwelling; Density per bedroom; Household building materials; City water; and Sanitation. > Profile and Family Composition: <ul style="list-style-type: none"> • Responsibility for the family; Ratio of children and adolescents, and adults; Presence of child labor in the family; Presence of children and adolescents hospitalized; Presence of elderly patients; Presence of disabled people in the family; Elderly in aggregated condition; and Illiteracy of the household head. > Access to employment and income in the family: <ul style="list-style-type: none"> • Labor of the adult individuals and monthly household income per capita. > Schooling condition: <ul style="list-style-type: none"> • Children and adolescents out of school; discrepancy between age and grade; and Youth and adults without basic education. 	2012
	Families Vulnerability Index regarding Disability and Dependency (IVF-ID)	Amendola et al. ^{8,9}	<ul style="list-style-type: none"> • Lack of vulnerability; • Access to knowledge; • Access to work; • Availability of resources; • Child development; • Housing Conditions; • Social relations; and • Health Conditions 	2011
	Youth Vulnerability Index regarding Violence (IVJ-Violence)	Brazilian Forum on Public Safety/ SEADE Foundation ^{14,15}	<ul style="list-style-type: none"> • Violence among young people; • Frequency in school and employment situation among young people; and • Poverty and inequalities in the county. 	2009

it continues

number of live births; percentage of young people between 15 and 17 who do not attend school; percentage of young people aged 18 to 24 who do not study or work; and percentage of people with less than half the minimum wage per capita in terms of family income.

In the index associated with the elderly, however, the vulnerability is operationalized according to the deficit accumulation approach, comparing it to fragility. In this sense, the variables assessed in this index address different dimensions compared to other selected indices, such as

the existence of a social support, participation in socially oriented activities and the realization of leisure activities.

The last theme category showed vulnerability from the perspective of a territory and was represented by seven synthetic indices. The most common variables in this category were related to schooling, occupation, income, demographic characteristics and sanitation.

The use of these summary measures requires an analysis of its strengths and limitations. According to Guimarães and Jannuzzi⁵³, it must be

Chart 3. continuation

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Synthetic indices of vulnerability from the perspective of the family and the life course	Family Social Vulnerability Index (FSVI)	Curitiba City Hall / Institute for Urban Research and Planning of Curitiba (IURPC) / Social Action Foundation (FAZ) ^{18,19}	<ul style="list-style-type: none"> • Household situation; • Type of property; • Number of rooms; • Number of people per household; • Number of disabilities; • Documentation; • Education Degree; • Professional Qualification / Occupation; • Number of children 0-1 year and 11 months old; • Number of children 2-6 years and 11 months old; • Number of children 0-6 year old who are left alone; • Number of children 0-3 year old who do not attend daycare; • Number of children 4-6 year old who do not attend daycare; • Number of children and adolescents 7-14 who do not attend school; • Senior Quantity at home; • Receiving social federal program wages; and • Family average income per capita. 	2008
	Social Vulnerability Index (SVI)	Andrew et al. ¹⁶	<ul style="list-style-type: none"> • Ability to communicate in the community; • Company at home; • Social Support; • Socially oriented activities; • Leisure activities; • Reflection on the relationships with family, friends and other matters that affect the individual's daily life; and • Socioeconomic status. 	2008
	Family Development Index (FDI)	Barros et al./ IPEA ²¹	<ul style="list-style-type: none"> • Lack of vulnerability; • Access to knowledge; • Access to work; • Availability of resources; • Child development; and • Housing Conditions. 	2003

it continues

admitted that “the culture of using social indicators was certainly strengthened in Brazil, granting legitimacy to various kinds to Synthetic Indicators”. The motivation for the implementation of these measures is based on the opportunity to summarize multidimensional and complex issues, the possibility of interpreting compared results with the trend analysis of a social reality and the checking of the developments and of

the reference unit chosen as dimensions for the monitoring of an individual's life course, living conditions in the households and living arrangements, as well as the social indicators of territories and environmental conditions.

Among the limitations^{2,3,53,54} pointed out to the use of synthetic indicators, however, we may include: i) the difficulty in gathering variables of various types and with different

Chart 3. continuation

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Synthetic indices of vulnerability from the perspective of the family and the life course	Social Vulnerability Index of Children and Adolescents of the Greater Porto Alegre (SVI - IJ)	City Hall of Porto Alegre ²²	<ul style="list-style-type: none"> > Environmental dimension: <ul style="list-style-type: none"> • Percentage of inadequate water supply; Inadequate sanitation percentage; and Percentage of inadequate garbage collection. > Cultural dimension: <ul style="list-style-type: none"> • Illiterate rate; and age-grade discrepancy rate. > Economic Dimension: <ul style="list-style-type: none"> • Indication of greater or lesser likelihood of families with insufficient monetary resources in the region or municipality. > Survival Security Dimension: <ul style="list-style-type: none"> • Infant Mortality rate and incidence of AIDS cases in children and adolescents; Percentage of illiterate teenage mothers and female heads of family; Homicide rate up to 18 years; and Rate of children and adolescents living on the streets. 	2003
	Youth Development Index (YDI)	Unesco ^{23,24}	<ul style="list-style-type: none"> > Education: <ul style="list-style-type: none"> • Relationship between the number of illiterates in the range of 15 to 24 years of age and the population of this age group in a given state; Percentage of young people aged 15 to 24 who attend school or Medium Higher Education in relation to the population of this range in a given state; and standardized average of proficiency scales of the 8th grade of elementary school and the 3rd year of high school in the areas of Portuguese language and mathematics as measured by the SAEB. > Health: <ul style="list-style-type: none"> • Number of deaths due to internal causes in 100 thousand young people aged 15 to 24 years; and Number of deaths from homicides, suicides and for traffic accidents among 100 thousand young people; > Income: <ul style="list-style-type: none"> • Family income per capita 	2003
	Youth Vulnerability Index (YVI)	Seade Foundation/ SP ²⁹⁻³⁵	<ul style="list-style-type: none"> • Annual rate of population growth in the intercensal period 1991-2000; • Involvement of young people between 15 and 19 years in the population of the district; • Mortality rate for murder of the male population between 15 and 19 years; • Participation of adolescent mothers aged 14 to 17, the total number of live births; • Average nominal monthly income of the household head; • Percentage of young people between 15 and 17 who do not attend school. 	2002

Source: Elaborated by the authors.

Chart 4. Vulnerability synthetic indices from the perspective of a territory and specific geographic areas.

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Vulnerability synthetic indices from the perspective of a territory and specific geographic areas	Social Vulnerability Index (SVI) - Amazônia	Ministry of Environment / German Technical Cooperation (GTZ) ¹¹	<ul style="list-style-type: none"> • Proportion of the total state population corresponding to county population. • Proportion of the total county population corresponding to childrens between 0 and 4 years of age. • Proportion of the total county population corresponding to people over 60years of age; • Share of total city population that has less than 4 years of study; and • Proportion of the total county population corresponding to household heads with income lower than 2 minimum wages. 	2010
	Social Vulnerability Index (SVI)	Fekete ¹⁷	<ul style="list-style-type: none"> • Fragility; • Socioeconomic conditions; and • Region. 	2008
	Social Vulnerability Index (SoVI)	Cutter et al. ^{25,26}	<ul style="list-style-type: none"> • Per capita income; [translate] • Median age; • No. Commercial establishments/mi²; • % employed in extractive industries; • % housing units that are mobile homes; • % African American; • % Hispanic; • % Native American; • % Asian; • % employed in service occupations; • % employed in transportation, communication and public utilities. 	2003
	Paulista Social Vulnerability Index (PSVI)	Seade Foundation/ SP ²⁹⁻³⁵	<ul style="list-style-type: none"> • % of literate people who are household heads; • % of persons responsible from 10 to 29 years; • Average age of the persons responsible; • % of children from 0 to 5 years of age; • % of women responsible from 10 to 29 years; • Average nominal income of the head of household; • % of responsible individuals under 3 minimum wages; • Household income per capita; • Average income of women who are the head of household; • % of households with per capita household income up to 1/2 the minimum wage; • % of households with per capita household income of up to 1/4 of the minimum wage; • % of persons responsible with incomplete primary education; and • Average years of schooling; 	2000

it continues

Chart 4. continuation

Thematic category	Name of the Synthetic-Index	Authors/ Institutions	Component Dimensions/ Indicators	Reference Date
Vulnerability synthetic indices from the perspective of a territory and specific geographic areas	Amazon Social Vulnerability Index (SVI-AM)	State Secretariat for the Planning and Economic Development of Amazonas ¹¹	<ul style="list-style-type: none"> > Income: <ul style="list-style-type: none"> • Average nominal income of the head of household; % of family heads earning up to one minimum wage or no income, resulting in the total number of family leaders for the census tract; > Education: <ul style="list-style-type: none"> • % of illiterate residents; % of illiterate household heads; % of household heads with eight years of schooling or less; Average years of schooling of the the head of household; > Cycle of Family Life: <ul style="list-style-type: none"> • Dependency ratio; Average number of persons per household; % Of households without water supply; % Of households without garbage collection; % Of households without sanitation - general system or septic tank. 	2000
	Social Vulnerability Index (SVI)	City Hall of Belo horizonte /PUC Minas ³⁷⁻⁴⁵	<ul style="list-style-type: none"> > Environmental: <ul style="list-style-type: none"> • Access to housing; and access to urban infrastructure services; > Cultural: <ul style="list-style-type: none"> • Access to education; > Economic: <ul style="list-style-type: none"> • Access to work; and access to income; > Legal: <ul style="list-style-type: none"> • Access to legal assistance; > Safety and Survival: <ul style="list-style-type: none"> • Access to health services; Food safety assurance; and Access to Social Security. 	1999
	Chronic Vulnerability Index (CVI)	Early Warning Working Group ⁴⁶	<ul style="list-style-type: none"> > Coping: <ul style="list-style-type: none"> • Basic Agricultural production per capita; Prevalence of cash crops; Number of cattle per capita; Quality and quantity of pasture and accessibility of the road; and percentage with access to potable water. > Risk: <ul style="list-style-type: none"> • Average price of maize and sorghum; Drought risk; Drought or extreme rain likelihood; Need of help for food in recent years; Variability of basic agricultural production; Malaria risk; Drought risk; Percentage of households headed by women; Drought or extreme rain likelihood; and Population density. 	1999

Source: Elaborated by the authors.

measurement scales in the construction of a model never before formalized; ii) the possibility of prioritizing erroneous decisions based on a mistaken and incorrectly designed model that favors bias of interpretation, or that is built without a theoretical framework. It is noteworthy that the results presented by these misguided models can provide simplistic and unidirectional understandings that hide important inequalities; iii) methodological clarity shortage of the steps required to build a synthetic indicator; and, iv) risk of replacement of the concept to be measured by the “reification” of the synthetic indicator.

Final Considerations

The literature review on indicators and methodologies adopted for the construction of synthetic indices evidences the existence of limitations to theoretically portray vulnerability.

An initial obstacle faced in the construction of these instruments is the difficulty of representing dynamic processes through quantitative and specific measures. It is essential that the index under development is based on a theoretical and conceptual basis, so that there is an adequate definition of what is to be measured and which evidences were used to support the choices in terms of dimensions and their components and indicators. In the case of vulnerability, in the face of its multiple approaches and process characteristics and not product characteristics, this is a complex task.

Another barrier in the index construction process is the unavailability of necessary information. Many studies end up working with alternative variables due to lack of reliable information that achieves the desired level of detail. There are situations where data does not exist or cannot be accessed, and there are also cases where it is difficult to perform geoprocessing and disaggregation in municipal units, despite the availability of data. Given the choice of using primary data, there is also the difficulty regarding operational and budgetary cost of research, which can prevent a detailed search. In addition, researchers use their own data collection instruments that make it difficult to compare the results in other regions.

These limitations do not preclude the use of indices; however, they signal caution that researchers should have to propose a measure that is capable of assisting vulnerability assessment processes in a particular region or group of people. Among the advantages of using vulnerability indices are the systemic analysis capabilities. When it is possible to use data that characterize the census tracts, for example, researches benefit from promoting the analysis of the most disaggregated level of population and socioeconomic data already collected in a standardized, systematic and regular manner, and they have national coverage. This is a reality found between the IBGE data, such as the Census and the National Household Sample Survey (PNAD). In addition, this level of detail allows the analysis of data at different levels of aggregation, according to the research plan and it makes the implementation of specific actions for certain population groups easier.

The possibility of using statistical techniques for the selection of variables that make up the synthetic index also constitutes a favorable point in this process. However, it should be noted that the empirical knowledge of the researcher and the other people involved with the research in terms of the reality being portrayed should not be ruled out in this procedure. Rather it must be added to the evidence at the time of choice of the factors that make up the index, which will ensure greater credibility to the instrument.

The elaboration of maps, based on the results estimated by the index, is also a plus, since mapping favors the visualization of important aspects of vulnerability. Thus, it emphasizes the priority areas of intersectoral coordination of policies and facilitates the longitudinal monitoring and cycle monitoring of specific policies in the development of territoriality.

Finally, synthetic indices can be important tools in the active management of territories and public health. They facilitate the evaluation of public policies implemented, especially if its periodic update is possible. They also enable the proposition and the most appropriate orienting measures and programs aimed at populations who are in vulnerability processes and have their response capacities reduced in terms of the promotion, protection and maintenance of health.

Collaborations

LRMA Schumann worked in the design, analysis and interpretation of data, as well as the design of the article and LBA Moura worked in the interpretation of data, critical review and approval of the final version to be published.

References

- Gallopín GC. Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* 2006; 16(3):293-303.
- Neto WJS, Jannuzzi PM, Silva PLNE. Sistemas de indicadores ou indicadores sintéticos: do que precisam os gestores de programas sociais. In: *Anais do XVI Encontro Nacional de Estudos Populacionais*; 2008; Caxambu. [informar as páginas]
- Jannuzzi PM. Indicadores para Diagnóstico, Monitoramento e Avaliação de Programas Sociais no Brasil. *Rev Serviço Público* 2005; 56(2):137-159.
- Zanella ME, Olímpio JL, Costa MCL, Dantas EWC. Vulnerabilidade Socioambiental do Baixo Curso da Bacia Hidrográfica do Rio Cocó, Fortaleza-CE. *Sociedade & Natureza* 2013; 25(2): 317-331.
- Instituto Paranaense de Desenvolvimento Econômico e Social (IPARDES). *Índice de Vulnerabilidade das Famílias Paranaenses: Mensuração a partir do Cadastro Único para Programas Sociais – CadÚnico*. Curitiba: IPARDES; 2012. Nota técnica.
- Huang G, London JK. Cumulative Environmental Vulnerability and Environmental Justice in California's San Joaquin Valley. *Int J Environ Res Public Health* 2012; 9(5):1593-1608.
- Freitas MIC, Cunha L. Cartografia da vulnerabilidade socioambiental: convergências e divergências a partir de algumas experiências em Portugal e no Brasil. *Rev Brasileira de Gestão Urbana* 2013; 5(1):15-31.
- Amendola F, Alvarenga MRM, Gaspar JC, Yamashita CH, Oliveira MAC. Validade aparente de um índice de vulnerabilidade das famílias a incapacidade e dependência. *Rev Esc Enferm USP* 2011; 45(Esp. 2):1736-1742.
- Amendola F, Alvarenga MRM, Latorre MRDO, Oliveira MAC. Desenvolvimento e validação do índice de vulnerabilidade de famílias a incapacidades e dependência (IVF-ID). *Rev Esc Enferm USP* 2014; 48(1):82-90.
- Almeida LQ. Por uma ciência dos riscos e vulnerabilidades na geografia. *Mercator - Rev Geografia da UFC* 2011; 10(23):83-99.
- Szlafsztein C, Marques O, Maia H, Prette M, Fischenich P, Altieri F. *Referências Metodológicas para mapeamento de Riscos Naturais na Amazônia: Mapeando as vulnerabilidades*. Brasília: MMA, GTZ; 2010.
- Reid CE, O'Neill MS, Gronlund CJ, Brines SJ, Brown DG, Diez-Roux AV, Schwartz J. Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspect* 2009; 117(11):1730-1736.
- Reid CE, Mann JK, Alfasso R, English PB, King GC, Lincoln RA, Margolis HG, Rubado DJ, Sabato JE, West NL, Woods B, Navarro KM, Balmes JR. Evaluation of a Heat Vulnerability Index on Abnormally Hot Days: An Environmental Public Health Tracking Study. *Environ Health Perspect* 2012; 120(5):715-720.
- Brasil. Ministério da Justiça (MJ). *Projeto Juventude e Prevenção da Violência – Primeiros resultados*. Brasília: MJ; 2009.
- Pereira NA. Ministério da Justiça. Fórum Brasileiro de Segurança Pública. *Metodologia de Construção do Índice de Vulnerabilidade Juvenil à Violência Ano Base 2010*. Brasília: MJ; 2013.
- Andrew MK, Mitnitski AB, Rockwood K. Social Vulnerability, Frailty and Mortality in Elderly People. *Plos One* 2008; 3(5):e2232.

17. Fekete A. Validation of a social vulnerability index in context to river-floods in Germany. *Nat. Hazards Earth Syst. Sci.* 2009; 9:393-403.
18. Leite LO. Índice de Vulnerabilidade Social Familiar e os Sistemas de Informações para sua Gestão: Estudo de Caso na Prefeitura Municipal de Curitiba. In: *XIII SEMEAD Seminários em Administração*; 2010; São Paulo.
19. Neri MC. *Parecer sobre o Índice de Vulnerabilidade Social das Famílias Curitibanas*. São Paulo: Fundação Getúlio Vargas; 2011.
20. Tibúrcio LH, Corrêa MP. Análise da vulnerabilidade da Microrregião de Itajubá por meio do IVG com vistas à mitigação dos impactos causados pelas mudanças climáticas. *Ambiente & Sociedade* 2012; 15(3):123-139.
21. Barros RP, Carvalho M, Franco S. *Índice de desenvolvimento da família (IDF)*. Rio de Janeiro: IPEA; 2003. Texto para discussão N° 986.
22. Prefeitura Municipal de Porto Alegre. *Índice de Vulnerabilidade Social Infante-Juvenil da Grande Porto Alegre*. Porto Alegre: Prefeitura de Porto Alegre; 2003.
23. Waiselfisz JJ. *Relatório de desenvolvimento juvenil 2003*. Brasília: Unesco; 2004.
24. Waiselfisz JJ. *Relatório de desenvolvimento juvenil 2007*. Brasília: Rede de Informação Tecnológica Latino-Americana (RITLA), Instituto Sangari, Ministério da Ciência e Tecnologia (MCT); 2007.
25. Cutter SL, Boruff BJ, Shirley WL. *Social Vulnerability to Environmental Hazards*. *Social Science Quarterly* 2003; 84(2):242-261.
26. Armas I, Gavris A. Social vulnerability assessment using spatial multi-criteria analysis (SEVI model) and the Social Vulnerability Index (SoVI model) – a case study for Bucharest, Romania. *Nat. Hazards Earth Syst. Sci.* 2013; 13:1481-1499.
27. Ceschini FL, Florindo AA, Benício MHDA. Nível de atividade física em adolescentes de uma região de elevado índice de vulnerabilidade juvenil. *Rev Brasileira de Ciência e Movimento* 2007; 15(4):67-78.
28. Borelli E. Vulnerabilidades sociais e juvenil nos mananciais da zona sul da cidade de São Paulo. *Rev Katálysis* 2012; 15(1):62-69.
29. Ferreira MP, Dini NP, Ferreira SP. Espaços e Dimensões da Pobreza nos Municípios do Estado de São Paulo. *Índice Paulista de Vulnerabilidade Social – IPVS. São Paulo em Perspectiva* 2006; 20(1):5-17.
30. Minuci EG, Almeida MF. Diferenciais intra-urbanos de peso ao nascer no município de São Paulo. *Rev Saude Publica* 2009; 43(2):256-266.
31. Pavarini SCI, Barham EJ, Mendiondo MSZ, Filizola CLA, Petrilli Filho JF, Santos AA. Família e vulnerabilidade social: um estudo com octogenários. *Rev Latino-Am Enfermagem* 2009; 17(3):374-379.
32. Francisco ER, Fagundes EB, Ponchio MC, Zambaldi F. Desenvolvimento de indicador de propensão à perda comercial de energia utilizando técnicas de estatística espacial e dados socioeconômicos: o caso da AES Eletropaulo. *Rev Administração Mackenzie* 2010; 11(4):178-197.
33. Inouye K, Barham EJ, Pedrazzani ES, Pavarini SCI. Percepções de Suporte Familiar e Qualidade de Vida entre Idosos Segundo a Vulnerabilidade Social. *Psicologia: Reflexão e Crítica* 2010; 23(3):582-592.
34. Martinez EZ, Roza DL, Caccia-Bava MCGG, Achcar JA, Dal-Fabbro AL. Gravidez na adolescência e características socioeconômicas dos municípios do Estado de São Paulo, Brasil: análise espacial. *Cad Saude Publica* 2011; 27(5):855-867.
35. Ferreira MP. *Índice Paulista de Vulnerabilidade Social*. São Paulo: Fundação SEADE; 2013.
36. Amazonas. Secretaria de Estado de Planejamento e Desenvolvimento Econômico do. *Índice de Vulnerabilidade Social do Amazonas*. [acessado 2014 jun 17]. Disponível em: <http://www.ivs.am.gov.br/oivsam.php>
37. Nahas MIP. Metodologia de construção de índices e indicadores sociais, como instrumentos balizadores da gestão municipal da qualidade de vida urbana: uma síntese da experiência de Belo Horizonte. In: Hogan DJ, Baeninger R, Cunha JMP, Carmo RL, organizadores. *Migração e Ambiente nas Aglomerações Urbanas*. Campinas: Unicamp; 2001. p. 461-487.
38. Bendo CB, Paiva SM, Torres CS, Oliveira AC, Goursand D, Pordeus IA, Vale MP. Association between treated/untreated traumatic dental injuries and impact on quality of life of Brazilian schoolchildren. *Health Qual Life Outcomes* 2010; 8:114.
39. Scarpelli AC, Oliveira BH, Tesch FC, Leão AT, Pordeus IA, Paiva SM. Psychometric properties of the Brazilian version of the Early Childhood Oral Health Impact Scale (B-ECOHIS). *BMC Oral Health* 2011; 11:19.
40. Zarzar PM, Jorge KO, Oksanen T, Vale MP, Ferreira EF, Kawachi I. Association between binge drinking, type of friends and gender: A cross-sectional study among Brazilian adolescents. *BMC Public Health* 2012; 12:257.
41. Serra-Negra J, Paiva SM, Oliveira M, Ferreira E, Freire-Maia F, Pordeus I. Self-Reported Dental Fear among Dental Students and Their Patients. *Int J Environ Res Public Health* 2012; 9:44-54.
42. Serra-Negra JM, Paiva SM, Auad SM, Ramos-Jorge ML, Pordeus IA. Signs, Symptoms, Parafunctions and Associated Factors of Parent-Reported Sleep Bruxism in Children: A Case-Control Study. *Braz Dental J* 2012; 23(6):746-752.
43. Bendo CB, Vale MP, Figueiredo LD, Pordeus IA, Paiva SM. Social Vulnerability and Traumatic Dental Injury among Brazilian Schoolchildren: A Population-Based Study. *Int J Environ Res Public Health* 2012; 9:4278-4291.
44. Santos LR, Almeida L, Teixeira LC, Bassi I, Assunção AA, Gama ACC. Adesão das professoras disfônicas ao tratamento fonoterápico. *CoDAS* 2013; 25(2):134-140.
45. Serra-Negra JM. Relationship between Tasks Performed, Personality Traits, and Sleep Bruxism in Brazilian School Children – A Population-Based Cross-Sectional Study. *Plos One* 2013; 8(11):e80075.
46. Burg J. Measuring populations' vulnerabilities for famine and food security interventions: the case of Ethiopia's Chronic Vulnerability Index. *Disasters* 2008; 32(4):609-630.
47. Pessanha JEM, Caiiffa WT, Kroon EG, Proietti FA. Dengue em três distritos sanitários de Belo Horizonte, Brasil: inquérito sorológico de base populacional, 2006 a 2007. *Rev Panam Salud Publica* 2010; 27(4):252-258.

48. Braga LS, Macinko J, Proietti FA, César CC, Costa MFL. Diferenciais intra-urbanos de vulnerabilidade da população idosa. *Cad Saude Publica* 2010; 26(12):2307-2315.
49. Frichel AAL, César CC, Caiaffa WT. Fatores associados à limitação funcional em Belo Horizonte, MG. *Rev Med Minas Gerais* 2011; 21(4):396-403.
50. Mendes LL, Nogueira H, Padez C, Ferrao M, Velasquez-Melendez G. Individual and environmental factors associated for overweight in urban population of Brazil. *BMC PublicHealth* 2013; 13:988.
51. Martins EF, Rezende EM, Almeida MCM, Lana FCF. Mortalidade perinatal e desigualdades socioespaciais. *Rev. Latino-Am. Enfermagem* 2013; 21(5):1070-1070.
52. Pitchon A. *Índice de Vulnerabilidade da Saúde 2012*. Belo Horizonte: Prefeitura de Belo Horizonte; 2013.
53. Guimarães JRS, Jannuzzi PM. IDH, indicadores sintéticos e suas aplicações em políticas públicas. *Rev Brasileira de Estudos Urbanos e Regionais (ANPUR)* 2005; 7(1):73-90.
54. Araújo EM, Rocha EMP. Trajetória da sociedade da informação no Brasil: proposta de mensuração por meio de um indicador sintético. *Ciência da Informação* 2009; 38(3):9-20.

Article submitted 07/28/2014

Approved 09/11/2014

Final version submitted 09/13/2014

ERRATUM

p. 2105

which reads:

Lívia Amaral Schumann

reads up:

Lívia Rejane Miguel Amaral Schumann

p. 2016, 2108, 2110, 2112, 2114, 2116, 2118, 2120

which reads:

Schumann LA

reads up:

Schumann LRMA

p. 2118

which reads:

LA Schumann

reads up:

LRMA Schumann