

A conceptual model for studies on social determinants of health in Brazilian municipalities

Modelo conceitual aplicável a estudos sobre determinantes sociais da saúde em municípios brasileiros

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Abstract

The conceptual models of Social Determinants of Health (SDH) available in the literature, although useful for comprehending mechanisms that affect the results of the health system on the living conditions of the population, present limitations regarding their application in empirical studies and, consequently, in guiding public health policies. This occurs because the categories adopted by these models are not adequately represented by indicators of homogeneous variables subject to mathematical or statistical manipulations in a simple relation system. This study aims to help filling this gap by proposing an operationally applicable SDH conceptual model - reproducible as a mathematical or statistical model - to support studies and define strategies concerning public health. We resorted to the literature to review previously developed conceptual models, identifying a set of SDH and presenting recommendations and choice criteria. Then we located reliable data sources supplying indicators and variables listed in historic series and proposed an applicable conceptual model, which requires specific methods and tools for a systemic approach for operationalization.

Keywords: Social Determinants of Health; SDH Conceptual Models; Systemic Approach.

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Resumo

Os modelos conceituais de determinantes sociais da saúde (DSS) disponíveis na literatura, embora úteis para compreensão dos mecanismos que afetam os resultados do sistema de saúde sobre as condições de vida das populações, apresentam limitações quanto à sua aplicação em estudos empíricos e, conseqüentemente, na orientação da gestão de políticas públicas de saúde. Isso ocorre porque as categorias adotadas por esses modelos não são adequadamente representadas por indicadores ou variáveis homogêneas, sujeitas a manipulações matemáticas ou estatísticas em um sistema simples de relacionamentos. Este estudo tem por objetivo contribuir para o preenchimento dessa lacuna, ao propor um modelo conceitual de DSS passível de aplicação operacional, ou seja, de ser reproduzido em modelos matemáticos ou estatísticos, a fim de subsidiar estudos e definir estratégias de saúde pública. O esforço recorre à literatura para revisar modelos conceituais consagrados, identificar um conjunto de DSS e apresentar recomendações e critérios de escolha. Na sequência, identifica fontes de dados confiáveis que disponibilizem indicadores e variáveis dispostos em séries históricas e propõe o desenho de um modelo conceitual aplicável, cuja operacionalização requer métodos e ferramentas próprios de uma abordagem sistêmica.

Palavras-chave: Determinantes Sociais da Saúde; Modelos Conceituais de DSS; Abordagem Sistêmica.

Introduction

Since 1991, conceptual models of social determinants of health (SDH) have been developed for comprehending mechanisms that affect the results of the health system on the living conditions of the population. These models report possible connections among SDH and locate strategic points for guiding policies. Although useful, they are often ill-suited to local contexts and the nuances of SDH and rarely offer policy-makers a clear direction for policy development (Exworthy, 2008). This occurs because they are considered disparate variables, gathering biological, genetic, behavioral, political, cultural, and social factors within the same conceptual framework, with few indications on their practical operationalization.

As addressed by Evans and Stoddart (1994, 2003), conceptual models available in the literature have limitations that hamper their application in public health policies management. The authors do not suggest treating the categories of their model as if they could be adequately represented by a homogeneous variable or subject to mathematical or statistical manipulations, which would render inadequate combined and integral reproduction. For them, overcoming this limitation requires a systemic approach rather than a simple and linear system of relationships, or even a causal factor - as health depends on everything, all the time.

This study aims to help filling this gap by proposing an operationally applicable SDH conceptual model - reproducible as a mathematical or statistical model - to support studies and define strategies concerning public health. For that, we resorted to the literature for reviewing previously developed conceptual models, identifying a set of SDH and presenting recommendations and choice criteria. Then we located reliable data sources supplying indicators and variables listed in historic series and proposed an applicable conceptual model, which requires methods and tools specific for a systemic approach for operationalization.

Conceptual models of reference

By synthesizing conceptual models adopted by different studies on health disparities, Roux (2012) reports that their borders are fluid and that intermediate options are adopted, combining mutual elements among them. However, the author stresses fundamental characteristics that distinguish the conceptual approaches and their usefulness for studies in this field, grouping them into four sets: (1) genetic model; (2) fundamental cause model; (3) pathways model; and (4) interaction model - the role of gene-environment interaction. Our study highlights models with greater emphasis on the contexts of environment, society, economy, infrastructure, health services productions, and results regarding health conditions.

Different studies analyzed and discussed the available models; yet, those that influenced this study proposal are the prevailing ones: Dahlgren and Whitehead (1991), Evans and Stoddart (1994), Diderichsen, Evans and Whitehead (2001), and Solar and Irwin (2007), as well as the Dimension Matrix for Evaluation of the Health System Performance, presented by Viacava et al. (2012), whose key characteristics will be address below.

Dahlgren and Whitehead (1991) developed a pioneering model, revised in 2007, whose conceptual structure should be deemed as an interdependent system to improve health and reduce health risks. They emphasize that health policies may target strategies at any of the four policy levels embodied in the model, without necessarily including all of them.

For Evans and Stoddart (1994, 2003), individual's behavioral and biological responses to social and physical environments and genetic load influence how they perceive their health and functional capacity and reflect on their well-being - health policy goal. Thus, the conclusive proof of a health policy is not only disease absence, but also its ability to provide well-being (Viacava et al., 2012).

According to Diderichsen, Evans and Whitehead (2001), many individual risk factors presuppose (or are strongly associated with) the social position and broader social context - area of residence (urban

or rural), work environment, or the social and economic policies in force. Social context and social position might as well play a key role in the "social consequences" of a disease or injury.

The model proposed by Diderichsen, Evans and Whitehead (2001), influenced, with some support, the development of the Commission on Social Determinants of Health model (Solar; Irwin, 2007), which contemplates: political and socioeconomic contexts, structural determinants of health inequalities, and intermediate determinants of health. Such a model differs from others due to its attributed importance on the political and socioeconomic contexts. Solar and Irwin (2007) state that their model contemplates social variables that cannot be directly measured at the individual level. This model is particularly important for our study, as it reinforces the possibility of studying SDH at the social level rather than at the individual level - which is often applied.

The authors adopted the terms suggested by Graham (2004) and declared that the expression "structural determinants" refers specifically to the components of people's socioeconomic position. These structural determinants, combined with the main characteristics of the socioeconomic and political contexts, comprise the social determinants of health inequities (or inequalities), operating by a series of intermediate social factors, or SDH.

Intermediate factors arise from the underlying social stratification setting and determine disparities in exposure and vulnerability regarding compromising health conditions. The models resemble each other by stressing genetic and biological processes mediating the effects of social determinants on health. The main categories of intermediate determinants on health are: material and psychosocial circumstances, behavioral and/or biological factors, and the health system itself as a social determinant.

Viacava et al. (2012) developed a method to evaluate the Brazilian health system, employing the Dimension Matrix for Evaluation of the Health System Performance, based on the proposal of the Canadian Institute for Health Information

and supported by the theoretical model of health production developed by Evans and Stoddart (1994). The dimensions applied by the Canadian model are: non-medical determinants of health (social, biological, and behavioral), health conditions, health system performance, and characteristics of both the community and health system (Raphael, 2009; Mr. Wolfson; Alvarez, 2002). The matrix added to this set the health system structure - its financing and human and material resources.

These SDH conceptual models present similarities within their structure, which implies the possibility of combining them into a compound form (Graham, 2004). Yet, Graham (2004), Exworthy (2008), and O'Campo (2012) warn against using public policies to face SDH for several reasons, among which we highlight four:

1. Each analyzed model presents an important contribution, but none can meet all requirements by itself. Yet, by combining elements of various models, we may reach a structure to spark the debate.
2. All SDH models are useful conceptual devices for identifying causal pathways that lead to different impacts on health. Yet, SDH models rarely offer policy-makers a clear direction for developing policies.
3. SDH call for concrete policies of different organizations and sectors. Intergovernmental and intersectoral partnerships are fundamental to formulate strategies to approach SDH, but evidence has shown that these partnerships are hampered by cultural, organizational, and financial issues.
4. Identifying, monitoring, and analyzing epidemiological changes over time are key for the political decision-making process. However, routine data are usually unavailable, of poor quality, or collected

during insufficient periods to help policy decision-making.

Any model entails a broad and diversified interpretation of the health needs of the population. To elaborate a proposal, we must consider the validity of the theoretical-conceptual assumptions of the presented models and the warnings arising from them, as well as the purpose of applying them in a practical way, focusing on the social rather than on the individual level, so that relations can be interpreted by mathematical or statistical models.

Social determinants of health: types and choice criteria

Each conceptual model applies a broad set of SDH to explain and relate factors that promote health. The first challenge is identifying which determinants can be considered to develop a conceptual model. The next is designating which SDH will compose the model. This process must consider the theory and the availability of reliable data, especially if the focus is the operational or empirical application of the model. Webster and Lipp (2009) and Raphael (2009) suggest applying objective and subjective variables and indicators; Chart 1 synthetically shows their wide variety.

A broad and diverse set of determinants, containing direct and indirect factors, may affect the health condition of the population. Whereas some SDH can be easily quantifiable, others cannot. Some refer to individual issues while others refer to social characteristics as a whole. Chart 1 shows a variety of SDH, which indicates that selecting them for a systematized model requires attention.

For selecting SDH, we must follow consistent criteria, appropriate to the model. Chart 2 - built on the contributions of Fulop et al. (2001), Exworthy (2008), Raphael (2009) and Craig, Thomas and Monroe (2015) - synthesizes the key recommendations for selecting a set of SDH to develop a conceptual model.

Chart 1 – Types of social determinants of health

Document or author	Objectives	Suggested indicators
The Ottawa Charter for Health Promotion (1986), Canada, World Health Organization (WHO).	Built on the Alma-Ata Declaration, the charter identifies the “prerequisites for health,” which concern social structure, and organization and distribution of economic and social resources. It focuses on the health needs of industrialized countries, without disregard to other regions of the globe.	Peace, shelter, education, food, income, stable ecosystem, sustainable resources, social justice, and equity.
Dahlgren and Whitehead (1992), Sweden (WHO).	It aims to stimulate debates among policy-makers and practitioners from various sectors. The authors formulated a four-level model of health determinants, represented in a rainbow form.	It identifies “living and working conditions” as contributors to health: agriculture and food production, education, work environment, unemployment, water and sanitation, health service, and housing.
International Centre for Health and Society (1996), London and New York.	It aims to identify the social bases for health, prosperity, and well-being.	Economic growth, income distribution, consumption, work organization, unemployment, family and social structure, education, and poverty.
Health Canada (1998), Canada.	It describes several determinants of health, many of which are social determinants of income, social status, and social support networks.	Education, employment and working conditions, physical conditions and social environments, genetics and biology, personal health, coping strategies and skills, healthy child development, health services, gender, and culture.
The University of York Conference organizers (2002), Canada.	The aims were: (1) to consider the conditions of the major SDH in Canada; (2) to explore their implications for the health of Canadians; and (3) to define policy guidelines for strengthening these SDH.	Aboriginal, early life, education, employment and working conditions, food security, gender, health services, housing, income and its distribution, security and social exclusion, and employment.
WHO’s European Office, United Kingdom.	It aims to raise issues for guiding policy-makers and public opinion.	Social class gradient (in health), stress, early life, social exclusion, work and unemployment, social support, drug addiction, food, and transportation.
Centers for Disease Control and Prevention (2006), United States.	It highlights SDH on socioeconomic status.	Transportation, housing, services access, discrimination (by gender, race, or class) and environmental or social stressors.

Source: Adapted from Raphael (2009)

Chart 2 – Synthesis of recommendations for selecting SDH

Fulop et al. (2001); Mills (2012); Gilson (2012)	Exworthy (2008)	Raphael (2009)	Craig et al. (2015)
Regarding management level or geographical approach	Regarding strategy	Regarding the association with theory, common sense, and management structures	Regarding the focus on systemic thinking and health systems
(1) Micro: individual level within the health system. It comprises suppliers and patients, citizens, managers, and political elites, as well as the relationship among them.	(1) Intra-institutional and intersectoral partnerships are key to formulate and implement policies for SDH, despite being one among many competing priorities for policy-makers attention and resources.	(1) They must be consistent with the SDH existing formulations and comply with the literature empirical basis.	(1) The governmental public health (federal, state, tribal, and local and territorial agencies that function as a governmental entity for public health).
(2) Meso: local health system – often referred to as municipal or district health system – and organizations, such as hospitals. It comprises broader social, economic, and political structures.	(2) Identifying, monitoring, and analyzing epidemiological changes over time is important for political decision-making. However, routine data are usually unavailable, of poor quality, or collected during insufficient periods to help policy decision-making.	(2) They must be consistent with the lay public’s understanding of factors influencing health and well-being.	(2) The public health system or partnerships that contribute for public health.
(3) Macro: national health systems – although its influence by both national and international context is recognized.	(3) Decentralization, which promotion is mainly controlled by the government, may be deemed as a smaller threat to national policies formulation than globalization.	(3) They must be clearly aligned with government structures (e.g. ministries or secretariats). SDH must be considered relevant by both decision makers and citizens.	(3) Other systems and structural components comprised by public health infrastructure (i.e. information systems, work force).
		(4) They must comply with an active part of government policy.	(4) Systems science employed in exploring and understanding causal ties, complex dynamics, and interactions.

Chart 2 depicts recommendations focused on the need to define management level and/or geographical approach, which establishes the scope of the chosen determinants. Acting upon social determinants - since it requires concrete policies of different organizations and sectors - entails an alignment with strategy - which involves different governmental structures, organizations, and public and private sectors - to ensure coherence with the lay public’s understanding of the factors influencing

health and well-being. Finally, the selected SDH should allow us to explore and systemically interpret both the relations among them and health system interactions with other systems.

The nature/type of study must guide the choice for a management level and/or geographical approach. Mills (2012) exemplifies that political and historical analyses often focus on the meso and macro levels, whereas epidemiology and psychology focus on meso and micro. Our study is mainly focused

on the meso level: we understand municipality as an analysis unit that limits the inclusion of subsystems interacting with the health system. Meso level comprises the local health system, involving broader economic and social structures that require concrete policies aligned with government structures. The next challenge posed for selecting SDH is developing a conceptual model in which these indicators or variables will be arranged and related.

Conceptual model for studies on SDH

Our proposed conceptual model has no intention of replacing existing models. However, it suggests an objective form of interpreting the probable scope and interrelationships among SDH in a more simplified, observable and applicable manner. It was influenced by the previously presented models, particularly by the model proposed by Solar and Irwin (2007), and selected SDH variables based on the recommendations depicted in Chart 2.

Its proposed set of SDH does not represent routine data at individual level and is aligned with active parts of government policies at municipal level. The SDH address information regarding: population; economy, public investment, and municipal management efficiency; environmental conditions; infrastructure; health conditions; health coverage; and health services production, provided by mortality indicators. Information on these matters are available in official electronic databases, with open access, arranged in time series, and with reasonable level of security and reliability. Namely:

- The Industry Federation of the State of Rio de Janeiro (Firjan);
- Brazilian Institute of Geography and Statistics (IBGE);

- Ministry of Health/National Registry of Health Establishments (MS/CNES);
- Ministry of Health/Department of Informatics of the Brazilian National Health System (MS/DataSUS);
- Ministry of Health/Primary Health Care Information System (MS/Siab);
- Ministry of Health/Outpatient Information Systems (MS/SIA);
- Ministry of Health/Hospital Information System (MS/SIH);
- Ministry of Health/Mortality Information System (MS/SIM);
- Ministry of Health/System on Public Health Budgets (MS/Siops);
- Ministry of Labor/General Register of Employed and Unemployed (MTb/Caged);
- Organization of Ibero-American States for Education, Science and Culture (Violence Map);
- Brazilian National Treasury/Secretariat Finance (STN/Finbra).

Such electronic systems hold data at national, state, and municipal levels. They enabled us to identify and select 41 indicators or variables (Chart 3) that were grouped into seven dimensions based on the literature. We may increase the amount of useful data by using the electronic systems mentioned or by identifying other reliable sources. Then they must be reduced and grouped, using, for example, exploratory factor analysis to ease its operationalization by other mathematical or statistical resources.

However, the consulted databases impose some limitations regarding time-series availability and missing or inconsistent data - especially for small municipalities; for example, in Siab - for some important information that could have been considered by our proposed model.

Chart 3 – SDH indicators and variables, available in official database

Domains	Indicator or variable	Source
Economic and socio-demographic	(1) Population	IBGE
	(2) <i>Per capita</i> income	IBGE
	(3) Employment and unemployment	Caged

continues...

Chart 3 – Continuation

Domains	Indicator or variable	Source
Sanitation and environmental conditions	(4) Number of housings built with masonry	Siab
	(5) Number of housings with water supply	Siab
	(6) Number of housings with electric power	Siab
	(7) Number of housings with sanitary sewage	Siab
	(8) Number of housings with waste collection	Siab
Municipal financial management results	(9) Fiscal Management Index – own revenue	Firjan
	(10) Fiscal Management Index – personnel costs	Firjan
	(11) Fiscal Management Index – investment expense	Firjan
	(12) Fiscal Management Index – liquidity	Firjan
	(13) Fiscal Management Index – cost of debt	Firjan
Public expenditure	(14) Health expenditure	Siops
	(15) Social welfare expenditure	Finbra
	(16) Internal control expenditure	Finbra
	(17) Culture expenditure	Finbra
	(18) Education expenditure	Finbra
	(19) Housing expenditure	Finbra
	(20) Sanitation expenditure	Finbra
	(21) Work/capitation/job guidance expenditure	Finbra
	(22) City planning expenditure	Finbra
Health services assistance and production	(23) Live births with seven prenatal consultations	DataSUS
	(24) Vaccination coverage rate	DataSUS
	(25) Outpatient services production by area of residence	SAI
	(26) Hospital services production by area of residence	SIH
	(27) Family Health Strategy coverage (%)	DataSUS
	(28) Oral health coverage (%)	DataSUS
	(29) Health insurance beneficiaries (%)	DataSUS
Availability of health system structure	(30) Number of primary medical centers	CNES
	(31) Number of specialized medical centers	CNES
	(32) Number of hospital beds in the public sector	CNES
	(33) Number of hospital beds in the private sector	CNES
	(34) Number of hospital beds	CNES
	(35) Number of health establishments	CNES
Mortality	(36) Overall mortality rate	SIM
	(37) Infant mortality rate	SIM
	(38) Neonatal mortality rate	SIM
	(39) Deaths from preventable causes (" 5 years)	SIM
	(40) Deaths from preventable causes (5 to 74 years)	SIM
	(41) Deaths from external causes	SIM/Violence map

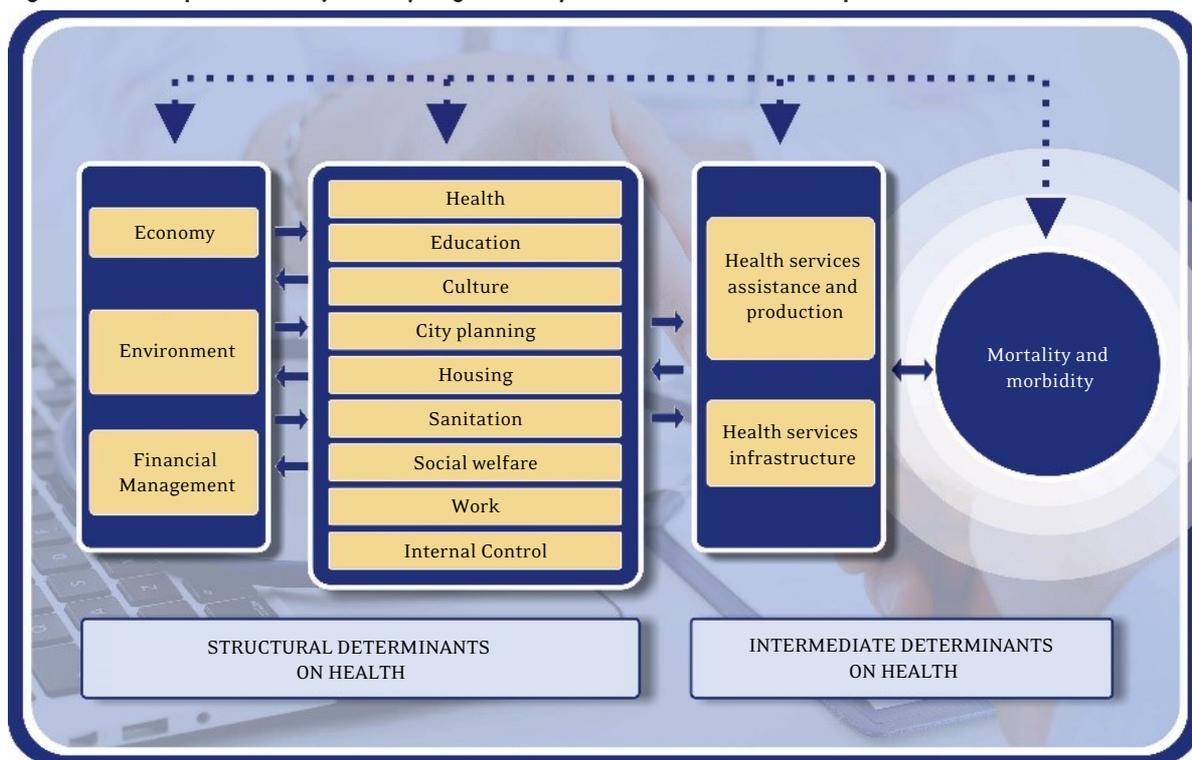
The elements shown in Chart 3 may be associated and analyzed in a systemic way - which is the approach proposed by WHO for studies on health systems. According to WHO, a health system consists of all organizations, people, and actions whose primary intent is to promote, restore, or maintain health. This includes efforts to influence SDH, as well as more direct health-improving activities (Pourbohloul; Kieny, 2011; WHO, 2007). Thus, systemic thinking tends to increase the perceived quality of the system constituting elements; or to increase the perception of the whole, its parts, and interactions within and between levels.

In this approach, an organization and its environment (context) are deemed as interrelated and interdependent parts that form a complex whole, rather than separate entities. Structures, interaction patterns, events, and organizational dynamics are factored as components of larger structures, which helps to anticipate (and not simply react to) certain occasions, and to better prepare for emerging challenges (Atun, 2012; Peters, 2014). It is thriving to adopt the systemic approach as theoretical focus for studies on health, which, according to Craig, Thomas and Monroe (2015), may include:

1. the governmental public health (federal, state, tribal, and local and territorial agencies that function as a governmental entity for public health).
2. the public health system or partnerships that contribute for public health.
3. other systems and structural components comprised by public health infrastructure (i.e. information systems, work force).
4. systems science employed in exploring and understanding causal ties, complex dynamics, and interactions.

Focusing on the system is of paramount importance for improving health systems performance (Mays; Scutchfield, 2015). Previous studies by Luke and Stamatakis (2012) and Willis et al. (2012) identified proper theories, methods, and tools for studying systems. (2012). Peters (2014) synthesized a set of resources applicable to studies in the field of health system, depending on their characteristics. Figure 1 shows a conceptual model for analyzing health systems in medium-sized Brazilian municipalities; this model demands a systemic approach based on appropriate metrics.

Figure 1 – Conceptual model for analyzing health systems in Brazilian municipalities



The conceptual model is described below. It recommends applying appropriate methods and tools for the systemic approach, in which the relations among elements would cover all indicators at the same time. We decided to reinforce the importance of each dimension by citing previous studies that applied conventional metrics.

Column I: formed by three dimensions (economic and socio-demographic, environmental, and fiscal) concerning demographic profile, income and employability, environmental indicators associated with basic sanitation, and governance - expressed by indicators of municipalities' fiscal management, a health system element (Savigny; Adam, 2009).

Studies on sanitation - Teixeira and Guilhermino (2006), Sousa and Leite Filho (2008), Ferrari and Bertolozzi (2012) and Rasella (2013) - reported negative and statistically significant associations between basic sanitation (access to piped water, sanitary sewage, and waste collection) and infant mortality.

Column II: formed by two dimensions (social investment and urban infrastructure); their indicators present municipal expenditures in public policies as a *proxy* for the importance attributed to them by municipal administration. The financing of health systems is also an element of the health system (Savigny; Adam, 2009). Other functions and activities of service provision and interventions in areas of public policy development engage with health policies development and results. Overall, public expenditure growth is expected to be significantly and negatively related to mortality (Ará et al. 2005; Andrade, 2010. Teixeira; Fortunato, 2014; Kim; Saada, 2013) or to expenditure, inequality, and infant mortality - as reported by Bradley et al. (2011) and Ramalho et al. (2013). Investing in internal control has acquired increasing importance in the Brazilian public management scope, either by national legislation requirement or by the acknowledgment of its relevance for successfully implementing public policies.

Column III: formed by two dimensions (infrastructure and health services provision), directly associated with facilities and equipment and the results in the provision of health services, as expressed by Savigny and Adam (2009). The infrastructure of health services is expressed in the availability of health facilities and primary and specialized medical centers, as well as hospital beds associated or not with the Brazilian National Health System (SUS).

Health services provision may be very broad. However, some indicators may not be available in reliable sources with time series arrangement. Public health care growth is often expected to negatively impact mortality rates. Researchers such as Cavalini and Leon (2008) and Lansky et al. (2014) developed

studies on the Family Health Strategy, the main health care program in Brazil.

The proposed model contemplates private health care. Overall, the increase in private health expenditures is expected to reduce public health expenditure; likewise, the increase in health insurance coverage is associated with reduced mortality indicators. There is a wide literature dedicated to private health care, such as Leite (2009), Nishijima, Cyrillo and Biasoto Junior (2010), Blanchette and Tolley (2001), Inoue, Rodrigues and Afonso (2015), Mou (2013) and Leal (2014).

The infrastructure of public and private health services in Brazil focuses on hospital-level care; primary care is contemplated by public assistance programs and health insurance coverage. Studies on this matter often report a negative and statistically significant association between health services infrastructure and mortality rates. However, this is not always the case. Hospital beds are poorly geographically distributed, medical supplies are concentrated by the private sector (health plans and insurance), and higher mortality rates are believed to occur in public beds, according to Santos (2009), Santos and Amarante (2010) and Machado (2014).

Column IV: formed by the mortality dimension, which indicates the quality of health services and, above all, population's health conditions. Ará et al. (2005), Leite (2009), Soares & Menezes (2010) and Allanson & Petrie (2013) consider mortality rate as an indicator of life and health conditions and a reflection of populations' health. Infant mortality rates are important indicators that play a key role in life expectancy at birth and have been historically used to assess populations' life and health conditions.

Final considerations

The literature presents useful conceptual models for understanding the relations and functioning of health systems, possible connections between different types of SDH, as well as indicating strategic points for guiding policies. However, these models

impose limitations regarding joint manipulation of categories, such as mathematical or statistical variables, hindering their application to public health policies.

Our study proposes a SDH conceptual model operationally applicable to support studies and management practices on public health. We resorted to conceptual models available in the literature to propose a model in which SDH variables or indicators could be systematized and better interpreted by quantitative methods. We collected data on the environment, society, economy, structure, public and private sector of health services, and on how they affect population's health. Our proposed model applied indicators or variables available in official databases with a time series arrangement, applicable to different types of metrics.

The resulting model comprises an active part of government policy, focusing on the Brazilian public health system and socioeconomic structures at municipal level. The model is operationalizable and reflexible, enabling adaptations according to data reliability. Our conceptual model proposed has no intention of replacing existing models. However, it offers a viable alternative application, as understanding its relation system may help formulate public health strategies.

Genetic and Biological aspects presented unreliable and insufficient data, so we excluded these elements from the model. We also did not consider qualitative data. These characteristics indicate limitations in the model proposed and suggest the possibility for further studies to explore.

The characteristics of all conceptual reference models, including the one proposed in our study, elicit the need for applying appropriate theories, methods, and tools for the systemic approach. We recommend this conceptual model to be tested by artificial intelligence resources, such as Bayesian networks, neural networks, or other compatible resource. The integral reproduction of the system of relationships among SDH may offer contextualized information to define health management strategies at municipal level.

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Authors' contribution

Melo has devised the model from the specialized literature. Costa has contributed selecting the variables and their links. Del Corso has contributed with revision and direction of the text.

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