

Urban upgrading and its impact on health: a “quasi-experimental” mixed-methods study protocol for the BH-Viva Project

Intervenções de requalificação urbana e o impacto na saúde: protocolo de estudo “quasi-experimental” com métodos mistos – Projeto BH-Viva

Intervenciones de renovación urbana y el impacto en la salud: protocolo de un estudio cuasi-experimental con métodos mixtos – Proyecto BH-Viva

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Abstract

There is little scientific evidence that urban upgrading helps improve health or reduce inequities. This article presents the design for the BH-Viva Project, a “quasi-experimental”, multiphase, mixed-methods study with quantitative and qualitative components, proposing an analytical model for monitoring the effects that interventions in the urban environment can have on residents’ health in slums in Belo Horizonte, Minas Gerais State, Brazil. A preliminary analysis revealed intra-urban differences in age-specific mortality when comparing areas with and without interventions; the mortality rate from 2002 to 2012 was stable in the “formal city”, increased in slums without interventions, and decreased in slums with interventions. BH-Viva represents an effort at advancing methodological issues, providing learning and theoretical backing for urban health research and research methods, allowing their application and extension to other urban contexts.

Vulnerable Populations; Epidemiologic Methods; Urban Health

Resumo

Há poucas evidências científicas de que estratégias de requalificação urbana contribuam para a melhoria da saúde e redução das iniquidades. Este artigo apresenta o delineamento do Projeto BH-Viva – estudo “quasi-experimental”, multifásico, com métodos mistos, incluindo componentes quantitativos e qualitativos, propondo um modelo de análise para monitoramento dos efeitos que intervenções no ambiente urbano possam ter sobre a saúde de moradores de vilas e favelas em Belo Horizonte, Minas Gerais, Brasil. Em análise preliminar observou-se diferenças intraurbanas na mortalidade proporcional por grupos etários, ao comparar áreas com e sem intervenção; a tendência de mortalidade de 2002 a 2012 mostrou estabilidade na cidade formal, aumento na vila sem intervenção e decréscimo naquela com intervenção. BH-Viva representa um esforço no avanço de questões metodológicas, fornecendo aprendizado e subsídios teóricos para a pesquisa e métodos de investigação em Saúde Urbana, possibilitando a aplicação e extensão em outros contextos urbanos.

Populações Vulneráveis; Métodos Epidemiológicos; Saúde Urbana

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Introduction

The approach known as social determinants of health has contributed to the discussion on the social, political, economic, cultural, behavioral, and individual phenomena that produce inequities in health. The approach has made great strides in our understanding of how inter-sector policy interventions help decrease such inequities and improve populations' health and quality of life ^{1,2,3}.

In addition, with growing urbanization and the need to develop methodologies to measure and evaluate how living in cities shapes the population's state of health, the urban health agenda is emerging within the field of Public Health ⁴.

Based on the premise that health events are associated with attributes of individuals nested in the "urban place" and in these individuals' aggregate properties, Urban Health incorporates the properties of the place and the role of the physical and social environments as health determinants of persons in places, demanding unique approaches ^{5,6,7,8}.

Since 2008, half of the world's population lives in cities ⁹, but the population distribution and growth in cities are not homogeneous. Most urban growth occurs in less developed countries, concentrated in poverty areas (vulnerable, risky, or precarious areas, irregular urban settlements, or slums). Some 863 million people currently live in slums, with a projected increase to 1.5 billion by 2030 if the demographic dynamics do not change significantly ¹⁰.

The phenomenon is no different in Brazil. The proportion of the population living in urban areas increased from 31.3% in 1940 to 81.2% in 2000, with the sharpest growth in metropolitan areas in Southeast Brazil, aggravating economic and social imbalances between regions and cities, and within cities themselves ¹¹.

The Brazilian process of urban occupation is expressed in the territory of large cities as a pattern of intense social and spatial segregation in which the growing manifestation of irregular urban settlements has become one of the structural (and structuring) forms of production of space in these cities ¹². This confirms the idea that the city should be understood as a territory produced by both irregular settlements and so-called formal spaces, with the two necessarily linking in the spatial configuration ¹³. Thus, there are two different cities: a "formal" city acknowledged by government, concentrating most urban investments, and an "informal" city built on its fringes, in which the phenomenon of illegal urban expansion combines with social exclusion ¹⁴, represented here by slums.

In this context of disordered urban growth producing health inequities, the Brazilian and international agendas recommend the development of intervention strategies based on the interconnection of policies beyond the health sector, requiring the evaluation of these policies and their impact on health and quality of life ^{1,2,15}.

A considerable volume of information in the literature has identified worse health outcomes in areas concentrating inequalities when compared to other areas in the same urban environment, or even comparing regions in the same country ^{1,4,12}.

This inequality in health, in addition to individual determinants, is subject to social determinants of health, considered "the causes of the causes" ¹. Such determinants include physical infrastructure (water, sanitation, housing, land titling, electricity) and social conditions (social exclusion or discrimination, poverty, and inequality on the basis of income, gender, or others), but also access to participatory activities in various spheres of government (education, employment opportunities, and others) ^{1,4,12}.

Some theoretical models orient studies that incorporate effects on health, people's behavior, and environmental sustainability based on urban planning interventions, political commitment, social actions in communities, and empowerment or a combination of these factors on the lives of residents in vulnerable areas ¹⁶.

It is expected that public policies focused on environmental upgrading and housing improvements will help improve health and reduce social inequities in health. Systematic reviews, although scarce, suggest that improvements in housing conditions lead to improvements in respiratory, mental, and overall health ^{1,16,17,18}.

Given the variety and complexity of urban interventions, there is still scarce evidence, especially in Brazil, that urban upgrading policies and strategies focused on the territory where people live contribute to improving health and reducing inequities. There are also gaps in the knowledge on the long-term effects of urban upgrading and urban renewal on health and social inequalities ^{19,20,21}.

In this sense, and understanding that the interconnected dimensions of housing, community ties, and the physical and social environment have the capacity to affect individual health through physical, mental, or social mechanisms, the BH-Viva Project was designed to evaluate the effects of urban upgrading on the health of the population living in vulnerable areas of the city of Belo Horizonte.

The BH-Viva Project

The BH-Viva Project (or Health of Residents in Special Social Interest Zones and Areas) was conceived to seek evidence in Urban Health and measure the effects of multifaceted urban interventions on the health and wellbeing of residents in such zones and areas (Special Zones of Social Interest, or ZEIS in the Portuguese-language acronym). ZEIS are areas of *vilas* (low-income alley housing) and *favelas*, defined by the Municipal Ordinance on Land Partitioning, Use, and Occupation²². The interventions were developed by the Belo Horizonte City Government under the Federal government's Growth Acceleration Plan, referred to in Belo Horizonte as PAC-Vila Viva, or the Vila Viva Project.

Described as a "natural experiment", the BH-Viva Project is a proposal for research and learning, whose main hypothesis is that public policies outside the health sector proper have a favorable effect on the population's health, including the residents that are directly exposed and the indirectly exposed neighboring areas and surroundings. The project proposes to investigate the impact of investment in housing, upgrading, and renewal in vulnerable areas on the health and wellbeing of individuals, families, and communities.

The study addresses the nature, extent, and effectiveness of these actions, based on different approaches, the central thrust of which is the production of knowledge to support urban policies for the improvement of the resident population's living conditions.

This article summarizes the BH-Viva Project's methodology, addressing its different stages and discussing its strengths and limitations, with a focus on the evaluation of the PAC-Vila Viva interventions in Belo Horizonte. As a case study, it presents the preliminary and descriptive results of exploratory analyses of secondary data on mortality from the 11-year period, by selected causes and areas for comparison.

Methods

This is a "quasi-experimental", multiphase study using mixed methods of analysis with quantitative and qualitative components and a comparative design. The set of quantitative and qualitative indicators will be used to consolidate a model that allows measuring useful characteristics for monitoring interventions in the urban environment.

Study scenario

The BH-Viva Project is conducted in Belo Horizonte, capital of Minas Gerais State in Southeast Brazil, with an estimated population of 2,375,151. Belo Horizonte is the sixth largest city in Brazil, with a per capita Gross Domestic Product (GDP) of BRL 13,636.00 and a Human Development Index (HDI) of 0.839, considered high (Instituto Brasileiro de Geografia e Estatística. <http://www.ibge.gov.br/cidadesat/topwindow.htm>; Prefeitura de Belo Horizonte. http://portalpbh.pbh.gov.br/pbh/ecp/comunidade.do?evento=portlet&pIdPlc=ecpTaxonomiaMenuPortal&app=estatisticaseindicadores&lang=pt_BR&pg=7742&tax=20040). However, these indicators fail to reflect the city's iniquities in income distribution, education, and health.

The municipality has some 600,000 households and 216 ZEIS, of which 186 slums areas with 385,395 residents (16.2% of the total population) and 130,670 households, in an area of 16.4 km² (5% of the city's total area) (Instituto Brasileiro de Geografia e Estatística. <http://www.ibge.gov.br/cidadesat/topwindow.htm>; Prefeitura de Belo Horizonte. http://portalpbh.pbh.gov.br/pbh/ecp/comunidade.do?evento=portlet&pIdPlc=ecpTaxonomiaMenuPortal&app=estatisticaseindicadores&lang=pt_BR&pg=7742&tax=20040). The population annual growth rate is heterogeneous, namely 3.5% in the "informal city" (defined here as ZEIS – *vilas* or *favelas*) and 0.7% in the "formal city"^{23,24}.

Interventions – PAC Vila-Viva

Beginning in 1993 with the creation of the Municipal Housing Policy, the Belo Horizonte City Government has developed programs aimed at the recovery and upgrading of the city's precarious settlements²².

A structural intervention called PAC-Vila Viva was planned for the slums (ZEIS), with the aim of producing profound changes in these areas²² and integrating them into the "formal city" after their land tenure regularization and environmental recovery.

The changes involve implementation and improvement of the roadway system, water supply and sewage networks, drainage, slope stabilization, housing improvements, removals and resettlements, land tenure regularization including titling, and promotion of the communities' socioeconomic development²².

These interventions are preceded by the elaboration of a Specific Global Plan (PGE, in Portuguese initials)²⁵, a planning instrument for a detailed and individualized diagnosis of the slums

with the purpose of creating an information and reference base to orient the government's interventions and community demands, identify paths for the social, urbanistic, and legal recovery of the settlements, and set priorities for implementing the actions and public works ²².

We highlight the importance of community participation in this process through the reference group, consisting of community leaders and other local residents that participate in the project's elaboration, monitoring, and follow-up and financial outlays.

PAC-Vila Viva covers three levels of approach: physical and environmental, legal, and social and organizational, with the respective lines of action described in Table 1.

The levels are elaborated concurrently in the following stages: (a) data survey on the legal, social/organizational, and physical/environmental situation; (b) integrated participatory diagnosis of the social/organizational, physical/environmental, and legal situation; (c) collectively elaborated and integrated proposal for social, physical, and land tenure regularization interventions; (d) timetable for implementation of activities, with prioritization of interventions and cost estimates; and (e) guidelines for land partitioning, use, and occupation ²⁶.

BH-Viva Project design

The proposed methodological approaches seek to grasp information that expands our understanding of the relations between the urban interventions and the resulting changes in the living conditions and health profile of the exposed populations.

Considering the funding sources, the study is divided into two phases: phase I covers an 18 month period from 2013 to 2015. Phase II will last longer, at least 24 months, from 2015 to 2016.

Table 2 shows Phases I and II with their respective specific objectives, methodological approaches, and current situation.

The current article presents the methodologies from the two phases and the results of the preliminary data analysis for Phase I.

We now briefly describe the methodological aspects of the various study components in Phases I and II.

- **Theoretical framework and conceptual structure or analytical model**

Based on a broad literature review covering key original articles and a systematic review to base the theoretical framework, a conceptual structure or analytical model was proposed for the data, based on the study's empirical nature and shown in Figure 1, which presents the study context, target variables, stakeholders, proposed interventions in the PAC-Vila Viva, and expected results, which will be evaluated in the two phases of the BH-Viva Project.

- **Data Warehouse (DW) elaboration**

The study areas were first defined on the basis of their historical characteristics, occupation, demographics, location in the municipality, presence or absence of intervention, and duration of interventions, drawing on official documents and information gathered in meetings with staff at the central, regional, and local levels of Belo

Table 1

Approaches and actions in the PAC-Vila Viva Program – Vila Viva Project.

Approaches	Actions	Interventions
Physical-environmental	Urban restructuring	Physical recovery: Roadway system (access and mobility); Public lighting; Recovery of alleys; Recovery of green areas; Installation of public and community equipment and reference areas for cultural and social activities (squares, areas for community contact and leisure) Sanitation: Urban drainage; Cleaning and recovery of thalwegs; Running water supply; Sewage system; Urban cleaning Geological-geotechnical consolidation: Slope stabilization; Reduction of earth movement; Construction of parks Housing interventions: Removals; Resettlements; Construction of new housing units
Legal	Land tenure regularization	Urban upgrading and legalization of ZEIS
Social-organizational	Social development	Social promotion and community development, especially based on the public equipment built in the area; Health and environmental education; Generation of work and income

Table 2

Phases, specific objectives, and methodological approaches of the BH-Viva Project.

Specific objectives	Approach	Current situation
Phase I	Theoretical framework *	
1. Construct Urban Health evaluation models from available secondary data	Quantitative	Concluded
2. Develop a Data Warehouse (DW) using available secondary databases	Quantitative	Under way
3. Study the intervention and its health impact from different stakeholders' perspectives (urban and social policymakers, population in the slums and in the formal city) through document analysis and field interviews	Qualitative	Under way
4. Measure the interventions' dynamics using DW, based on historical series of indicators in an 11-year period, comparing areas with and without interventions and the formal city, with the interventions' type and timetable as the reference	Quantitative	Under way
Phase II	Conceptual framework **	
5. Construct evaluation models based on primary data with variables related to Social Determinants of Health (SDH) as components	Quantitative	Scheduled for future
6. Conduct a household survey with the set of constructs or domains from the Urban Health field	Quantitative	In elaboration
7. Conduct Systematic Social Observation of the study slums	Quantitative	In elaboration
8. Conduct a qualitative study to evaluate the impact of urban interventions on health services and the population's health	Qualitative	In elaboration
9. Monitor and measure the impact of interventions on segments in slums with different intervention times and their surroundings	Quantitative	Scheduled for future
10. Combine the results and analyses from different approaches and theoretical frameworks to construct an integrated Urban Health evaluation model	Quantitative and Qualitative	Scheduled for future

* Theoretical framework: describes a broad relationship between things;

** Conceptual structure or analytical model provides a more specific definition of this relationship. The conceptual structure specifies the variables to be explored in the research, the determinant variables and the response variables. It also includes possible statistical procedures to be used in analyzing these relations.

Horizonte Urban Development Company (URBEL). Case and control slums also show similarities in terms of their health indicators and organization of health services.

The following 11 study areas are called "case slums", "control slums", and the "formal city":

Case slums: five slums with interventions concluded or under way: Serra, Morro das Pedras, Pedreira Prado Lopes, São Thomaz, and São José;

Control slums: five slums with no interventions under way: Santa Lúcia, Ventosa, Cabana, Vista Alegre, and Jardim Felicidade;

Formal city: the population of Belo Horizonte, excluding its slums.

Figure 2 shows the geographic location of the case and control slums in the city.

Concurrently with the choice of areas, health events were selected for investigation, obtained from different secondary data sources, as shown in Table 3.

The events were selected as important health markers for urban populations and because they were potentially sensitive to modifications in the urban environment ²⁷.

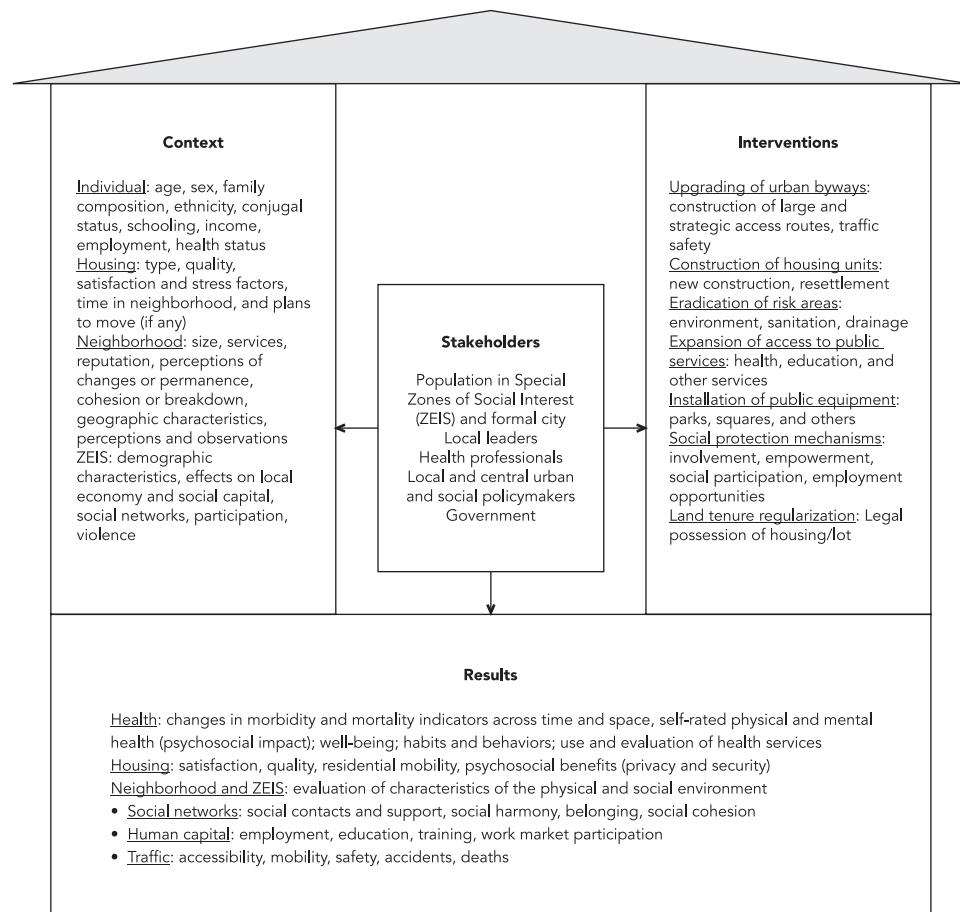
Population data were obtained from the 2000 and 2010 national censuses. Definition of the population for the inter-census periods (2002 to 2009 and 2011 to 2012) used a correction method by estimation of the population growth, considering the age and gender distribution.

The scope, typology, and timetable for the interventions were obtained from the URBEL headquarters and regional offices in the study slums. Based on this information, databases for public works were geoconstructed, considering the census tract and census tract clusters in the study areas, grouped according to the interventions' characteristics: (i) Roadway works: opening of roadways, earthmoving, paving, sanitation, drainage, and lighting; (ii) Housing: housing unit construction and removals; (iii) Public equipment: construction of schools, daycare centers, health units, and public squares; (iv) Eradication of risk areas; (v) Park construction. The presence of one or more intervention groups was considered a "natural experiment".

Information from different sources on public works, population, and events was georeferenced using the municipal Geographic Information

Figure 1

Summary of the study model, principal stakeholders, events, and results evaluated in the BH-Viva Project.



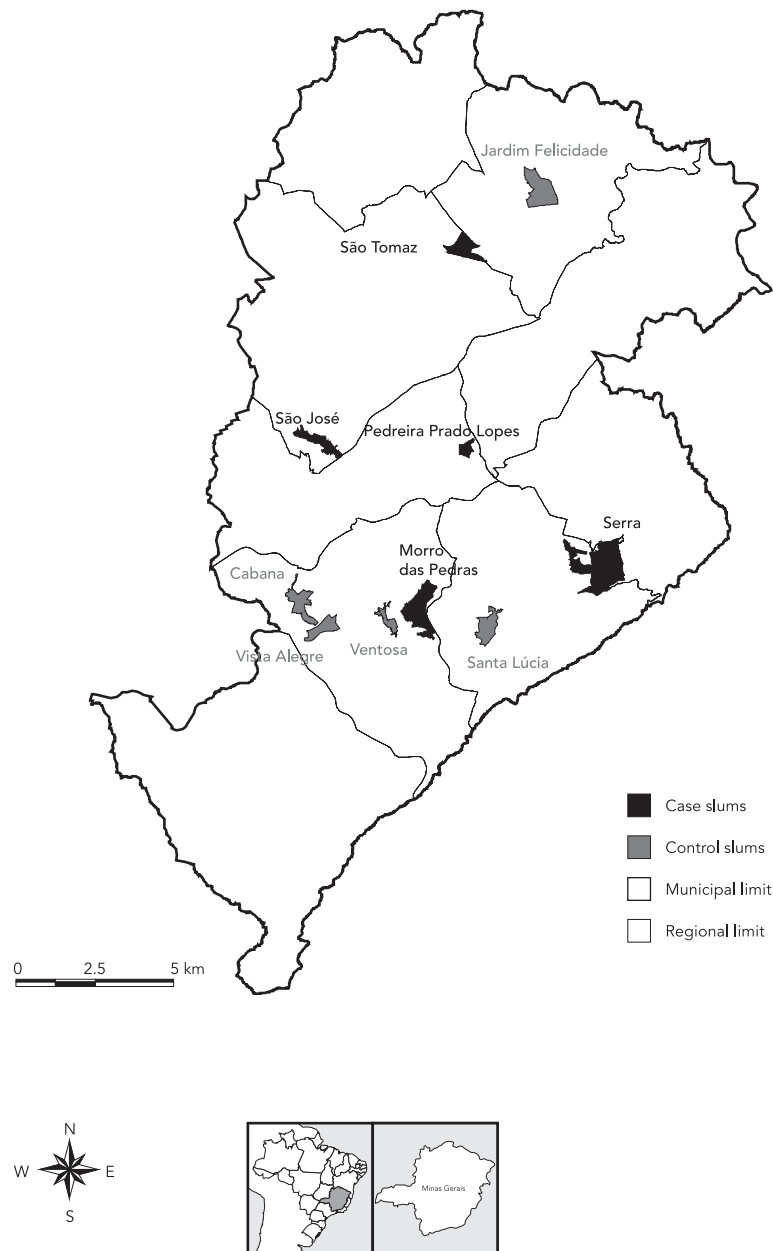
System (GIS), administered by the Belo Horizonte Data Processing Company (PRODABEL), (URBEL), and the Belo Horizonte Municipal Health Secretariat (SMSA-BH).

The selected areas were demarcated by creating georeferenced polygons based on the census tract grouping used in the 2010 Population Census⁹. Whenever the boundaries of the census tracts for 2000 were not consistent with the boundaries for 2010²⁸, a new adjustment was made to calculate the proportional population for 2000²⁹. Variables from the census tracts were calculated by analysis of the National Registry of Addresses for statistical purposes, produced by the Brazilian Institute of Geography and Statistics (IBGE), Google Earth images ([https://www.google.com.br/maps/place/Belo+Horizonte+-+MG/@-](https://www.google.com.br/maps/place/Belo+Horizonte+-+MG/@-19.9027163,-43.9640501,40777m/data=!3m1!1e3!4m2!3m1!1s0x00a690cacacf2c33:0x5b35795e3ad23997)

[19.9027163,-43.9640501,40777m/data=!3m1!1e3!4m2!3m1!1s0x00a690cacacf2c33:0x5b35795e3ad23997](https://www.google.com.br/maps/place/Belo+Horizonte+-+MG/@-19.9027163,-43.9640501,40777m/data=!3m1!1e3!4m2!3m1!1s0x00a690cacacf2c33:0x5b35795e3ad23997)) using its timeline tool, and the PRODABEL aerial photography base. This procedure allowed identifying the number of households and estimating the populations of the resulting polygons, considering the mean number of household members. To identify the census tract corresponding to the residence of an individual with a given health event, the respective address was georeferenced. When a given address was not found in the geographic database, the closest address on the same street with a street number of +/- 100 was georeferenced. Despite the possibility of locating an event in a neighbor census tract we prefer to use this method instead to ignore this partial information. We also used the geo-

Figure 2

Selected slums (ZEIS) in Belo Horizonte, Minas Gerais State, Brazil, for the BH-Viva Project.



graphic database for stretches of streets to better locate the events. Thus, when a street contained a single stretch, the event was georeferenced to its centroid.

Construction of the Data Warehouse was finalized with an open-code databank manage-

ment system that uses structured search language and with the development of specific software for database handling, linkage, and basic analyses that were hosted in an own server.

Table 3

Selected health events for the BH-Viva Project and respective data sources.

Events	Data source
Asthma	SIH
Dengue	SINAN
Tuberculosis	SIM and SINAN
External causes	SIH and SIM
Diseases of the circulatory system	SIH and SIM

SIH: Hospital Information System; SIM: Mortality Information System; SINAN: Information System for Diseases of Notification.

- **Document analysis and interviews with managers and the population**

The first phase included analysis of documents on the planning and implementation of the interventions and their follow-up and community participation (PGE). The documents were first classified by year of publication and source, followed by the preliminary analysis proposed by Cellard³⁰, based on five dimensions: content, authors, text's authenticity, nature of the text, and text's key concepts and internal logic. The following stage consisted of content analysis as proposed by Bardin³¹ and Minayo³².

Semi-structured interviews were held using previously defined scripts, based on Minayo³² and the theoretical-conceptual model proposed for the complete study. The interviews targeted key informants such as urban and social policy-makers, community representatives and references for population in the slums and formal city. The number of interviewees was defined according to the saturation criterion, namely the repetition of discourse content by the interview subjects. Interviews were taped and later transcribed for analysis. This information is currently in the process of thematic content analysis^{31,32,33}.

- **Analysis of historical series of health indicators**

Currently under way are the analyses of the selected secondary health indicators, based on comparison of the case and control slums and formal city, with the interventions' timetable as the reference. The databases are processed via SDSS.

The following will be performed for all the selected events: descriptive analysis; univariate analysis; multilevel multivariate analysis; analysis of the events' spatial distribution.

- **Phase II: household survey, systematic social observation, and qualitative study**

Phase II, will include a household survey, Systematic Social Observation (SSO), and qualitative study in the following slums, categorized according to the presence and duration of intervention (exposure): Vila Serra, the oldest, followed by Vila Morro das Pedras, both with median duration of interventions, Vila São Tomás, with recently initiated interventions, and Vila Santa Lúcia, awaiting interventions, and Vila Cabana, for which no interventions are scheduled, as the control slums (Figure 2).

Next, representative population samples will be selected in the study areas and their respective surroundings, according to a sampling method that will take into account the population distribution according to the study's target categories. Change in quality of life will be used as the parameter for the sample calculation.

The household epidemiological survey will address the following domains, according to the Urban Health Observatory (OSUBH) experience in previous surveys³⁴: self-rated health; evaluation of health services; perceived characteristics of the living environment; other social determinants of health (evaluation of public services, social breakdown, social cohesion, social capital, and participation, perception of neighborhood – violence, noise, etc.); lifestyles; governance; quality of life; and perception of the intervention^{35,36,37}.

All collected data will be duly processed to allow the descriptive, univariate, and multivariate analyses, multilevel analyses of the individual and aggregate risk factors, and analysis of the events' spatial distribution patterns.

SSO is a methodology for collecting data from the physical and social surroundings in health research. SSO is the identification and standardization of visual interpretation of the characteristics (in different domains) of street segments that are traversed by observers that systematically record their observations^{4,38}. SSO will be conducted in the same selected areas as the household survey according to the methodology developed by the OSUBH.

The qualitative study will be based on semi-structured interviews with health service professionals and users, aimed at evaluating the interventions' impact.

The information will be processed with thematic content analysis^{31,32} and based on Minayo³² as the theoretical reference and the theoretical-conceptual model proposed for the full study.

The research project was approved by the Ethics Research Committees of Federal Uni-

versity in Minas Gerais and SMSA-BH (CAAE 11548913.3.0000.5149).

Preliminary results

This article presents the preliminary analyses of cause-specific mortality trend for selected causes (infectious diseases, cardiovascular diseases, chronic diseases, and external causes), using the historical series of information from 2002 to 2012 in three areas of the city. We selected a case slum (with interventions, Vila Serra), a control slum (without interventions, Vila Santa Lúcia), and the formal city as a whole (excluding all the city's slums). The case and control slums were selected on the basis of their similar historical, geographic, demographic, and health characteristics. Beginning in 2005, the following were implemented in the case slum: road construction, housing construction, construction of public equipment, eradication of a risk area, and park construction (the "natural experiment").

Cause-specific mortality rates were calculated for the three areas, and the mortality trends were compared by smoothing curves. We also analyzed age-specific mortality during the 11 years, comparing the three selected areas.

Figure 3 shows the results of the mortality trend analyses for the 11 years of the study.

From 2002 to 2004 there was a downward trend in mortality in the case slum (Serra), sta-

bilization until 2008, and from then until 2012 another downward trend in mortality rates. The slum without interventions (Santa Lúcia) showed a downward trend in mortality from 2003 to 2008 and an upward trend from 2008 to 2012. Thus, beginning in 2008, three years after the beginning of the urban upgrading interventions, there was an inverse trend in mortality rates when comparing the areas with and without interventions.

When investigating the intra-urban differences in age-specific proportional mortality, comparing the three areas, the formal city showed a lower proportional mortality in young people and adults (15%) and a higher proportion of elderly (46%). The slum without interventions (Santa Lúcia) showed higher proportional mortality of young people and adults (30%) and a lower proportion of elderly (21%). The slums with interventions (Serra) showed intermediate proportional mortality of young people (24%) and elderly (26%), that is, a different mortality profile when compared to the slum with no intervention. All three areas showed a low proportion of deaths in children under five years, probably for two reasons: the overall downward trend in under-five mortality (with an important decrease in deaths from infectious diseases) and the events selected for analysis, especially external causes and cardiovascular diseases, both which have low occurrence in children in this range age (Figure 4).

Figure 3

Historical mortality series according to selected causes. BH-Viva Project, 2002-2012.

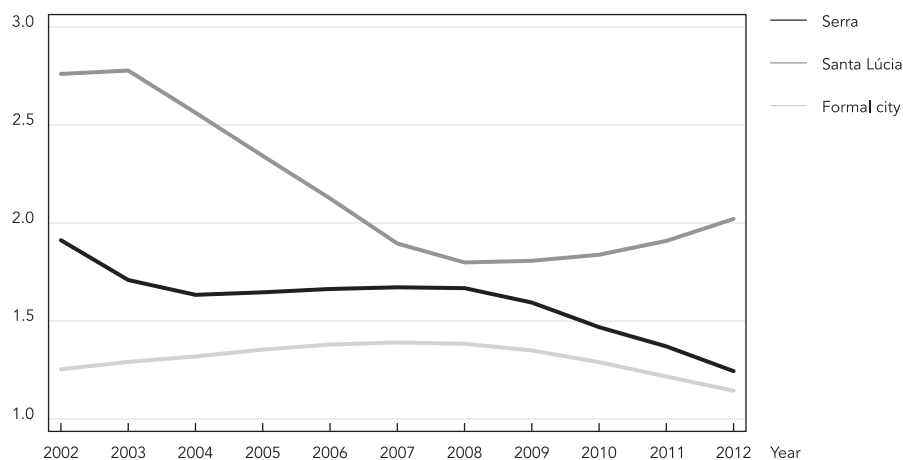
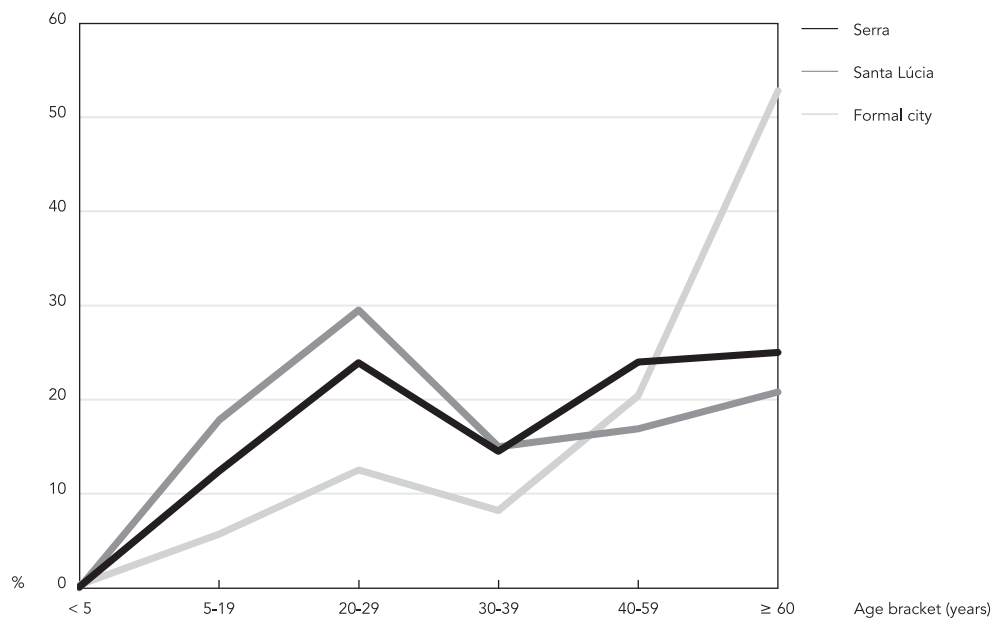


Figure 4

Age-specific proportional mortality according to selected causes. BH-Viva Project, 2002-2012.



Discussion

This article presents a summary of the BH-Viva Project with its different phases and methods. In addition, presents the preliminary results of cause-specific mortality trends in the 11 years of study in three selected areas.

The preliminary results of the mortality analyses point to important differences in proportional mortality, especially among young people, suggesting that in the most vulnerable areas this age bracket contributes the largest proportion of deaths, justifying urban interventions not directed explicitly to health for improving living conditions. The preliminary conclusions suggest a relevant change in the mortality profile in the area with urban upgrading interventions, with a significant decrease in the mortality rates during the study period when compared to the area without interventions and the formal city.

Importantly, this analysis only focused on certain outcomes, given the complexity and the ongoing elaboration, verification, and harmonization of the database, considering the multiple data sources and characteristics, thus preventing the approach to historical series of other events such as dengue, tuberculosis, hospitalizations

due asthma and diarrhea in children, potentially impacted by vulnerable conditions in urban areas. Further analyses are already underway and others are still in the preliminary phase.

Although the study is still quite incipient given its extensive possibilities for results, some methodological limitations should be anticipated, given the complexity and the impossibility of conducting a controlled intervention study.

Evaluation of the health impact of urban upgrading projects encounters numerous difficulties: studies focused on a single event, limited knowledge of the sensitivity of indicators to urban interventions, use of inadequate indicators for such interventions, short follow-up of the effect or outcome to make a clear impact evaluation; and simplified or linear designs for evaluating complex interventions^{20,21,39}.

The inherent limitations and difficulties in such studies, particularly negligible or even inconsistent associations, fall into three major types: methodological limitations, limitations in the intervention's implementation, and limitations of the intervention's theoretical framework.

Methodological limitations include the impossibility of obtaining a randomized control group. This limitation makes the study suscep-

tible to selection bias and has important repercussions on the risk estimates and a strong possibility of overestimating the effects, since it is not a randomized experimental design. Meanwhile, the impossibility of avoiding the control group's contamination by the intervention due to geographic proximity or even social interaction can favor underestimation of any effect, resulting in absence of association. Other issues relate to inherent differences between the groups exposed versus unexposed to the intervention. Could the exposed groups be more resilient, more demanding, or in some way different from the others?

Another aspect relates to the health events and the time needed for their occurrence: i.e., which events could be expected in the short, medium, or long term for the comparison groups? And would negative effects be properly observed? Does the study address both sides of the hypothesis? What about unexpected effects? Will they be properly monitored, and what would their time frames be? And what about the health impacts from self-reporting? What direction will these effects take?

As for the limitations related to intervention, much could be said about segmentation. That is, is the target of the intervention really the population most in need of improving its health through improvement in its living environment? What about the quality of the intervention? When compared to the previous situation, have the improvements made the environment much better, somewhat better, or worse? What is the scope of the intervention for solving multiple problems? Has the intervention improved only some but not all of the problems?

Finally, the theoretical limitations of intervention models leave some doubts. These can include causal inference from the association between the context and health. Is the association strong enough to lead to significant health benefits? Could improvements for certain specific social determinants impact health, or would a holistic approach be more adequate? Could the presence of high disease rates in this specific context mean management of the disease, fostering resilience, delaying progression, aiding recovery, avoiding comorbidity, and relieving stress? Is it possible to measure all this? Do the interruptions and delays associated with urban upgrading "cancel out" the benefits? This is particularly relevant, because to modify communities can alter their social support networks and lead to inequities in the intervention, that is, avoidable inequality between groups.

In the attempt to minimize unaddressed factors, adjustments will be made to the analyses, taking into account the specific characteristics of

the population and areas. The use of secondary data will also allow constructing a baseline (prior to the intervention) and will contribute to understanding the profile of the study population and areas. Furthermore, the comparative design, considering areas with and without interventions (cases and controls) with similar baseline geographic, demographic, socioeconomic, and historical characteristics will help reduce the potential confounding factors inherent to such studies. Given the current impossibility of launching a longitudinal study prior to the interventions, for the epidemiological study we selected areas with similar demographic and historical characteristics and with different intervention times. The control slums, currently without urban interventions, can serve as the basis for the new longitudinal studies. A third phase is being elaborated for the future, awaiting funding, scheduled for 2016 to 2018, to include a longitudinal study of the slums with different intervention times.

Despite the limitations, BH-Viva is an innovative project that uses mixed methods to evaluate health impacts in populations living in vulnerable areas of the city of Belo Horizonte, the scenario for urban interventions by PAC-Vila Viva.

In this study, the choice of indicators with potential sensitivity to urban interventions, the combination of quantitative and qualitative methods, and an adequate evaluative design can provide important information on objective changes in health and the residents' perception and understanding of the interventions. The proposed analytical methodologies will allow the interpretation of the findings at both the individual and aggregate levels in the study areas.

The methods and proposed analytical model should provide a valid and robust approach for evaluating the health impact of integrated policies on populations, and will be useful for recommendation of healthier cities with inter-sector policies that truly contribute to the residents' quality of life. We intend that the methods and model can serve as a reference for other studies that aim to evaluate the health effects of urban upgrading.

Conclusion

Studies on the health effects of urban upgrading and renewal are still scarce in the Brazilian and international literature. The BH-Viva Project is an effort to advance the methodological issues and provide theoretical backing for methodological research and learning in urban health. It is hoped that the results can be applied to other urban contexts.

Resumen

Hay poca evidencia científica de que las estrategias de regeneración urbana contribuyen a mejorar la salud y reducir las inequidades. En este trabajo se presenta el diseño del Proyecto BH-Viva, estudio "cuasi-experimental", de múltiples fases, con métodos mixtos, incluidos los componentes cuantitativos y cualitativos, que propone un modelo de análisis para el seguimiento de los efectos de las intervenciones en el entorno urbano puede tener en la salud residentes de las aldeas y los barrios marginales en Belo Horizonte, Minas Gerais, Brasil. En el análisis preliminar hubo diferencias intra-urbanas en la mortalidad proporcional por grupos de edad, al comparar las zonas con y sin la intervención; las tendencias de la mortalidad de 2002 hasta 2012 se mantuvieron estables en la ciudad formal, el aumento en el pueblo sin ninguna intervención y disminuyen de que con la intervención. El BH-Viva es un esfuerzo para avanzar en cuestiones metodológicas, proporcionando el aprendizaje y la base teórica de los métodos de investigación y de investigación en salud urbana, lo que permite la aplicación y la extensión en otros contextos urbanos.

Poblaciones Vulnerables; Métodos Epidemiológicos; Salud Urbana

Contributors

A. A. L. Friche, M. A. S. Dias and W. T. Caiaffa participated in the conceptualization, analyses, preparation of the manuscript, and revision of the final version. P. B. Reis and C. S. Dias participated in the organization, data analysis, and revision of the manuscript.

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References

- World Health Organization. Our cities, our health, our future: acting on social determinants for health equity in urban settings. Report of the Knowledge Network on Urban Settings to the WHO Commission on Social Determinants of Health. Kobe: WHO Centre for Health Development; 2007.
- Comissão Nacional sobre Determinantes Sociais da Saúde. As causas sociais das iniquidades em saúde do Brasil. Relatório final, 2008. http://bvs.ms.saude.gov.br/bvs/publicacoes/causas_sociais_iniquidades.pdf (accessed on 23/Feb/2015).
- Buss PM, Pellegrini Filho A, Espiridião MA. Promoção da saúde e seus fundamentos: determinantes sociais de saúde, ação intersetorial e políticas públicas saudáveis. In: Paim JS, Almeida-Filho N, organizadores. Saúde coletiva – teoria e prática. Rio de Janeiro: MedBook; 2014. p. 305-26.
- Caiaffa WT, Ferreira FR, Ferreira AD, Oliveira CLO, Camargos VP, Proietti FA. Saúde urbana: "a cidade é uma estranha senhora, que hoje sorri e amanhã te devora". *Ciênc Saúde Coletiva* 2008; 13:1785-96.
- Vlahov D, Freudenberg N, Proietti FA, Ompad DC, Quinn A, Nandi V, et al. Urban as a determinant of health. *J Urban Health* 2007; 84:i16-126.
- Ompad DC, Galea S, Caiaffa WT, Vlahov D. Social determinants of the health of urban populations: methodologic considerations. *J Urban Health* 2007; 84:i42-i53.
- Dias MAS, Friche AAL, Oliveira VB, Caiaffa WT. The Belo Horizonte Urban Health Observatory: its history and current challenges. *Cad Saúde Pública* 2015; 31 Suppl:S277-85.
- Diez Roux AV. Health in cities: is a systems approach needed? *Cad Saúde Pública* 2015; 31 Suppl:S9-23.
- United Nations Department of Economic and Social Affairs. World urbanization prospects, the 2011 revision. New York: United Nations Department of Economic and Social Affairs; 2012.
- United Nations Human Settlements Programme. Streets as public spaces and drivers of urban prosperity, 2013. <http://mirror.unhabitat.org/pmss/getElectronicVersion.aspx?nr=3513&alt=1> (accessed on 26/Feb/2015).
- Instituto Brasileiro de Geografia e Estatística. Tendências demográficas: uma análise da população com base nos resultados dos Censos Demográficos 1940 e 2000. http://www.ibge.gov.br/home/estatistica/populacao/tendencia_demografica/analise_populacao/1940_2000/comentarios.pdf (accessed on 02/Mar/2015).
- Santos SM. Desigualdades socioespaciais em saúde: incorporação de características da vizinhança nos modelos de determinação em saúde. In: Barcellos C, organizador. A geografia e o contexto dos problemas de saúde. Rio de Janeiro: ABRASCO; 2008. p. 165-92.
- Neves IMZC, Cunha JMC. Urbanismo, demografia e as formas de morar na metrópole: um estudo de caso da Região Metropolitana de Campinas. *Cadernos Metrópole* 2010; 12:211-37.
- Grostein MD. Metrópole e expansão urbana: a persistência de processos "insustentáveis". *São Paulo Perspec* 2001; 15:13-9.
- Comissão para os Determinantes Sociais da Saúde, Organização Mundial da Saúde. Redução das desigualdades no período de uma geração. Relatório final, 2010. http://www.who.int/social_determinants/thecommission/finalreport/en/ (accessed on 23/Feb/2015).
- Thomson H, Thomas S, Sellstrom E, Petticrew M. The health impacts of housing improvement: a systematic review of intervention studies from 1887-2007. *Am J Public Health* 2009; 99:S681-92.
- Kearns A, Tannahill C, Bond L. Regeneration and health: conceptualising the connections. *Journal of Urban Regeneration and Renewal* 2009; 3:56-76.
- Thomson H, Petticrew M, Morrison D. Health effects of housing interventions: a systematic review of intervention studies. *BMJ* 2001; 323:187-90.
- Egan M, Kearns A, Mason P, Tannahill C, Bond L, Coyle J, et al. Protocol for a mixed methods study investigating the impact of investment in housing, regeneration and neighbourhood renewal on the health and wellbeing of residents: the GoWell programme. *BMC Med Res Methodol* 2010; 10:1-12.
- Roshanak M, Rodríguez-Sanz M, Malmusi D, Muntaner C, Díez E, Bartoll X, et al. The effects of an urban renewal project on health and health inequalities: a quasi-experimental study in Barcelona. *J Epidemiol Community Health* 2014; 68:811-7.
- Turley R, Saith R, Bhan N, Rehfuess E, Carter B. Slum upgrading strategies involving physical environment and infrastructure interventions and their effects on health and socio-economic outcomes. *Cochrane Database Syst Rev* 2013; 1:CD010067.
- Pereira CVL, Afonso AS, Magalhães MCF. Programa Vila Viva: intervenção em assentamentos precários. <http://portalpbh.pbh.gov.br/pbh/ecp/contents.do?evento=conteudo&idConteudo=22546&chPlc=22546&pIdPlc=&app=salanoticias> (accessed on 26/Feb/2015).
- Brito F, Souza J. Expansão urbana nas grandes metrópoles: o significado das migrações intrametropolitanas e da mobilidade pendular na reprodução da pobreza. *São Paulo Perspect* 2005; 19:48-63.
- Brasil. Lei nº 10.257, de 10 de julho de 2001. Regulamenta os artigos 182 e 183 da Constituição Federal, estabelece diretrizes gerais da política urbana e dá outras providências. *Diário Oficial da União* 2001; 11 jul.
- Brandenberger F. Plano global específico: um instrumento de planejamento urbano em assentamentos subnormais. Seminário de avaliação de projetos IPT em meio ambiente: assentamentos urbanos precários. São Paulo: Instituto de Pesquisas Tecnológicas do Estado de São Paulo; 2001.
- Prefeitura Municipal de Belo Horizonte. PGE – planejamento. <http://portalpbh.pbh.gov.br> (accessed on 02/Jun/2014).

27. Caiaffa WT, Almeida MCM, Oliveira CL, Friche AAL, Matos SG, Dias MAS, et al. O urbano sob o olhar da saúde: o caso de Belo Horizonte, Minas Gerais, Brasil. *Cad Saúde Pública* 2005; 21:958-67.
28. Instituto Brasileiro de Geografia e Estatística. Censo demográfico de 2010: agregado por setores censitários dos resultados do universo. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2011.
29. Instituto Brasileiro de Geografia e Estatística. Censo demográfico de 2000: agregado por setores censitários dos resultados do universo. 2ª Ed. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2003.
30. Cellard A. A análise documental. In: Poupart J, Deslauriers J, Groulx AL, Mayer R, Pires AP, organizadores. *A pesquisa qualitativa: enfoques epistemológicos e metodológicos*. Petrópolis: Vozes Editora; 2008. p. 295-316.
31. Bardin L. *Análise de conteúdo*. Lisboa: Edições 70; 2010.
32. Minayo MCS. *Pesquisa social: teoria método e criatividade*. 29ª Ed. Petrópolis: Editora Vozes; 2010.
33. Costa DS. *A implantação do Programa Vila Viva em áreas de Belo Horizonte: uma análise documental [Masters Thesis]*. Belo Horizonte: Centro de Pesquisas René Rachou, Fundação Oswaldo Cruz; 2015.
34. Friche AAL, Xavier CC, Proietti FA, Caiaffa WT, organizadores. *Saúde urbana em Belo Horizonte*. Belo Horizonte: Editora UFMG; 2015.
35. Fernandes AP, Andrade ACS, Ramos CGC, Friche AAL, Dias MAS, Xavier CC, et al. Leisure-time physical activity in the vicinity of Academias da Cidade Program in Belo Horizonte, Minas Gerais State, Brazil: the impact of a health promotion program on the community. *Cad Saúde Pública* 2015; 31 Suppl:S195-207.
36. Andrade RG, Chaves OC, Costa DA, Andrade ACS, Bispo S, Felicissimo MF, et al. Overweight in men and women among urban area residents: individual factors and socioeconomic context. *Cad Saúde Pública* 2015; 31 Suppl:S148-58.
37. Meireles AL, Xavier CC, Andrade ACS, Friche AAL, Proietti FA, Caiaffa WT. Self-rated health in urban adults, perceptions of the physical and social environment, and reported comorbidities: the Belo Horizonte Health Study. *Cad Saúde Pública* 2015; 31 Suppl:??-??.
38. Freitas ED, Camargos VP, Xavier CC, Caiaffa WT, Proietti FA. Instrumento para condução de observação social sistemática: métodos e resultados da concordância interobservadores. *Cad Saúde Pública* 2013; 29:2093-104.
39. Bonda L, Egan M, Kearns A, Tannahill C. GoWell: the challenges of evaluating regeneration as a population health intervention. *Prev Med* 2013; 57:941-7.

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