

Health and wellbeing in the changing urban environment: complex challenges, scientific responses, and the way forward

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With rapid global urbanization, the importance of understanding relationships between the changing urban environment and human health and wellbeing is being increasingly recognized. However, the science underlying the complexity of linkages is poorly developed. In this paper, we explore the different types of health and wellbeing risks in the urban environment, their dynamic, ever evolving nature, and define both their spatial and socioeconomic dimensions. We also present the new innovative program on Health and Wellbeing in the Changing Urban Environment that was launched recently by the International Council for Science (ICSU) wherein an integrated systems approach is recommended to address this complexity. We conclude by identifying key elements needed for the success of the new science initiative.

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Introduction

With more than half of world's human population now living in cities, and with that proportion projected to increase into the foreseeable future, cities are important determinants of future sustainability and human health and wellbeing [1,2]. The value of linking urban environment and health and wellbeing outcomes is now well recognized [3–5], however the myriad relationships are far from being understood scientifically, let alone guiding urban environmental planning, policy and governance.

Urban environments are multi-faceted, diverse, dynamic, complex and evolving, as are the underlying features for

human health and wellbeing [6,7]. Globally, health status is better in urban areas than in rural areas. The many positive aspects of urban life, such as employment, higher incomes, better opportunities for education, and access to health care, encourage rural to urban migration. However, recent studies show that such advantages of urban health status can be eroded due to the adverse impacts of urban environment, increased fat in diet, and sedentary ways of living [8,9]. Potential urban hazards with associated health risks include substandard housing, crowded living conditions, contaminated food, unclean water, inadequate sanitation, poor solid waste disposal services, air pollution, and congested traffic [10]. Furthermore, within cities there are often significant health inequities, such as differences in life expectancy for people living in slum conditions than those living in wealthy neighborhoods [11]. These health inequities can be traced back to differences in social and living conditions of urban dwellers, and variable environmental qualities in cities. There are significant equity issues in terms of access to health-care, vaccination coverage, and rate of work related accidents and injuries in cities [12]. To identify these urban health inequities, it is important to disaggregate data on health and health determinants and to examine spatial and socio-economic differences.

Importantly, effective interventions to improve urban health and wellbeing often require action well beyond those that can be offered by the formal health sector. There is a need for the engagement of many different societal sectors (e.g. water supply, sanitation, housing, transport, education) and all levels of government – local, provincial and national [10]. The complexity of the linkages between urbanization, environmental change and human health and wellbeing, requires a systems approach towards health, wellbeing and urban environment. The following section illustrates the health and wellbeing challenges presented by rapid urbanization, and the multifaceted linkages between urban environment and wellbeing. Section 3 presents the new ICSU program on Health and Wellbeing in the Changing Urban Environment, as a response from the international scientific community to tackle these challenges. Section 4 outlines a way forward for the successful implementation of such an initiative.

Complex and multifaceted linkages between urban environment and wellbeing

Typology of health risks in the urban environment

The health risks associated with the urban environment are diverse [6,7,13–23]. Many cities face at least five types

of health threats: (1) Infectious diseases that thrive when people are crowded together in substandard living conditions; (2) Acute and chronic diseases such as respiratory disease and pulmonary cancer that are associated with industrial pollution; (3) Chronic, non-communicable diseases that are on the rise with unhealthy urban lifestyles (physical inactivity, unhealthy diets, tobacco smoking, and harmful use of alcohol); (4) injuries resulting from motor vehicle collisions, violence, and crime; and 5) Climate change related health risks, for example, heat stress and changed patterns of infectious disease, which are considered as one of the biggest health risks in the 21st century and are likely to exacerbate existing risks.

Effective solutions for these problems are more probably be found by addressing the urban environment rather than narrowly focusing on healthcare. Provision of adequate housing and basic infrastructure is essential for Type 1 health threat posed by infectious diseases. Air and water pollution by industries are considered the main causes for the rapid increase in respiratory diseases, pulmonary and breast cancers. Therefore, improvement of the Type 2 health outcome can only be achieved by addressing the industrial pollutions in cities. Urban lifestyle to some extent is predetermined by how cities are planned and designed. It has been shown that sprawling cities have more overweight people than do compact, walkable cities [24,25]. Residents in automobile dependent cities are exposed to increased traffic accidents. On the contrary, evidence shows that the presence of natural environments in cities helps reduce stress, maintain emotional health, and help expedite recovery from illness [26]. Therefore, in addition to other efforts in the health area, urban planning and design would be indispensable to address Type 3 and Type 4 risks. Mitigating and adapting to climate change in cities will be needed to address Type 5 risks, and increasing evidences show effective climate mitigation or adaptation measures have health co-benefits [27–29].

Such linkages are by no means unidirectional. There is a strong case for enhanced focus on human health and wellbeing in achieving urban sustainability. Health and wellbeing of citizens including physical and

emotional health, is at the center of sustainability agenda, as social and economic pillars of sustainability cannot be achieved without total wellbeing of the community [30]. Close coupling of urban sustainability, climate change and health provides the opportunity to pursue co-benefits in multiple fronts, for example, walkable cities and obesity reduction, urban green areas and climate adaptation agenda such as heat stress reduction, and clean energy and respiratory disease reduction [31,32,33*,34*,35*].

An urban environmental evolutionary perspective

Change in cities and their environs can be conceptualized as an evolutionary process [6]. The experience of developed cities show that the dominant issues in cities are related to a phase of poverty, industrial pollution, followed by lifestyle and consumption related issues, with typical urban health risks associated with each phase (Table 1). While the transition of such risks are typically associated with economic development [21], many developing cities face the environmental issues and associated health risks in a condensed and telescoped way rather than following a clear sequence [6]. The principal health concerns are different for each stage of development but their associations are not well understood. Chronic diseases that used to be associated with affluent lifestyles in high income cities are increasing in low-income cities leading to a dual burden. In addition, climate change adds new health risks, that is, heat stress, affecting cities regardless of their income level [36]. Thus, public health management needs to be adaptive and continually evolving to meet the new challenges of urbanization and economic development. Such conceptualization has value because it identifies typical transitions in the evolution of cities and includes an aspirational stage 4 of the healthy eco-city (Table 1). More importantly, rather than treating the transitional steps as a fixed or stylized pattern, an evolutionary perspective puts more focus on the non-linearity of the trajectories experienced by different cities, the mechanism of change, and the potential for leap-frogging intermediate steps [37]. The ambition should be to avoid the known pitfalls of the industrialization and consumption phases and strive to move directly from stages 1 and 2 to 4.

Table 1

Typical stages of urban evolution and characteristic environmental conditions and health issues

Stage	Characteristic environmental conditions	Characteristic health issues
1. Poverty	Contaminated water, poor sanitation, poor housing	Infectious diseases, malnutrition, injury
2. Industrial	Air pollution and land contamination by chemicals and solid waste	Chronic respiratory disease, injury, heart disease
3. Consumption	High levels of consumption of water, energy and other natural resources	Chronic diseases (obesity, diabetes, heart disease, cancers), injury, depression
4. Healthy eco-city	Conditions of life in balance with nature	Maximum health potential

Source: Adapted from [6,38].

Spatial and socioeconomic dimensions of the linkages

Intra-city disparities in health outcomes are linked to socio-economic circumstances of the population [19]. Urban poor communities are disproportionately exposed to health risks due to the lack of proper infrastructure, poor access to health care, information and knowledge networks. Such disparities are not exclusive to, but more prominent in, developing cities, suggesting a universal need for better urban management and governance to achieve equitable health and wellbeing outcomes.

In addition to above, there are strong inter-city disparities in health and wellbeing. Some of the health risks associated with urban environment are affected by the size of the cities. Recent studies in China show that larger cities tend to have poorer respiratory disease outcomes than smaller or medium sized cities [8]. Further research is required to understand the underlying mechanisms.

The health implications of cities reach beyond the urban boundaries.

In developing countries, where cities lack or have inefficient sewage treatment infrastructure, untreated waste loaded with harmful agents such as heavy metals is discharged to water bodies, used by farmers for irrigation. These harmful chemicals then enter the food system and subsequently harm human health [39,40]. Environmental management in some developed cities has forced polluting industries to relocate to smaller cities or rural areas, which can result in the transfer of health risks from urban to peri-urban and rural areas [41]. Farms on the outskirts of the cities are increasingly being replaced by industrial or residential buildings, often driven by economic growth in cities [42]. Peri-urban communities are vulnerable to changing land use pattern [43^{*}]. Heat islands, which were an urban phenomenon, are now moving to such industrialized peri-urban areas. There is an urgent need to establish empirical evidence and causal links to elucidate such urban-rural links.

The new ICSU program on Health and Wellbeing in the Changing Urban Environment

Complex challenges require integrated and coordinated scientific responses. To address the enormous health challenges created by the accelerating global urbanization, the International Council for Science (ICSU), representing global scientific bodies, has launched an innovative program on Health and Wellbeing in the Changing Urban Environment [44^{**},45^{**}]. The new program focuses on the use of systems analysis to provide insight for policy and decision makers. It is ambitious and requires a paradigm shift in the conceptualization and implementation of urban health research. It entails the use of system modeling tools such as mathematical modeling, enabling the use of quantitative data to study complex interactions, relationships and feedback between multiple, non-linear factors with the goal of achieving concrete, scientific-based

recommendations to policy makers. It involves engagement of multiple stakeholders viz. scientists, policy-makers, representatives of civil society, health-related national and international bodies, as well as funders.

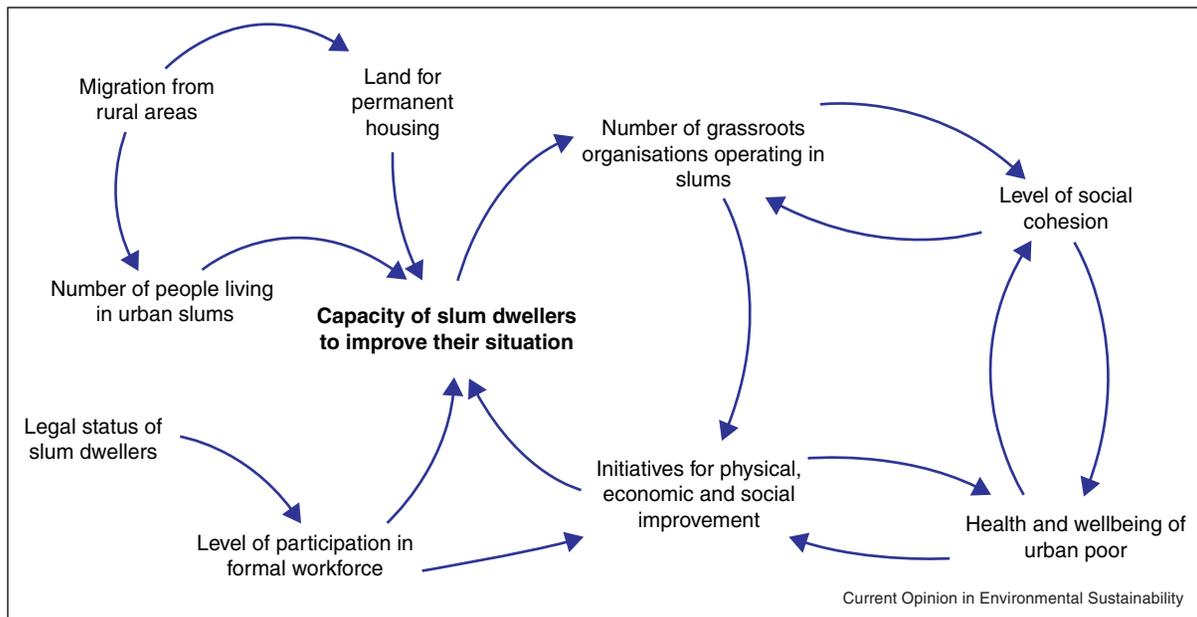
The new program starts with the premise that health is not merely the absence of disease but also includes total wellbeing with physical, mental and social components. These components are shaped by *proximal* and *distal* determinants (Figure 1) where the former refers to individual genetic makeup, nutrition, living conditions, opportunities and values and on risk-based individual choice of behavior. The *distal* determinants refer to the natural and built environments, food, energy, socioeconomics, governance and political systems which indirectly influence health. Both components act synergistically or antagonistically to increase or decrease the subsequent effects. They need to be viewed as a continuum though they can be better investigated for variables when viewed as separate influences. No single element or variable acts in isolation or at a single scale, and the framework for the study of health and wellbeing demonstrates a complex interplay of variables that can be quantitatively addressed.

The systems approach offers features that are essential to addressing the complex challenges of urban health. It is integrative and interdisciplinary, it reveals interrelationships and nonlinearities, identifies constraints and incompatibilities, incorporates feedbacks and highlights the dynamics of the system. This approach promotes the development of comprehensive data bases, advanced computer technology, improves cost effectiveness and provides predictions when data are sparse. Analytical models used during such analysis would span disciplines and provide true insight for policy making.

The challenges in applying systems analysis include deficiencies in availability and quality of data in many rapidly growing cities and disciplines. Confidentiality and ethics of obtaining health data must also be kept in mind when undertaking such a study. For example, data would be required on health status of individuals and families that migrate from rural areas or across porous borders, variables that exist across socio-economic groups, settlements, different governance systems and health economics. Such data need to be managed efficiently for easy access while maintaining confidentiality and enabling comparative analysis across different cities and areas. Data linkage is another major challenge as data on health statistics, economic growth and the environment collected routinely by different agencies in the city may not be linked to capture the complex interactions that occur.

The ICSU program recognizes that different countries have different urban problems, different governance systems, and different socioeconomic challenges. In

Figure 2



A simplified illustration to demonstrate some of the linkages and feed back influences involved in the capacity of slum dwellers/informal settlements to improve total health and wellbeing. Each subsystem can be studied individually and then linked for overall approach to coordinated management of informal settlements using quantitative systems analysis. Where data is qualitative for a subsystem such an approach could also be used to link it initially to other subsystems and obtain quantitative data at a later stage. Mathematical modeling is integral to understanding the dynamic complex nature of the interactions. Source: [45**].

in the changing urban environment [48,49**]. Systems science using systems analysis tools such as mathematical modeling, can provide quantitative information that is more likely to provide real life solutions, predictions about subsequent events and cost benefit information.

The way forward

The new ICSU program on Health and Wellbeing in the Changing Urban Environment was approved by the ICSU 30th General Assembly in Rome in October 2011. In moving forward with the program, the following approaches are necessary.

Systems approach broadly defined: A systems approach, which reflects the complex and dynamic interactions between various aspects of urban environment and human wellbeing, both within and beyond the cities, is essential to effectively understand and analyze the linkages, including the feedbacks and tradeoffs. One example of such broadly defined systems approach is that cities be approached as a coupled social–ecological system, where health is a key indicator for the performance of the system [50]. Such approach needs to be adopted for the scientific understanding of the interactions, as well as evaluating policy and interventions designed to tackle the issues.

Table 2

General Criteria for research projects

Study element	Requirements and description
Study focus	Projects must focus on health and wellbeing as affected by the urban environment.
Scientific team	Must consist of interdisciplinary groups across medical, physical, social sciences and engineering.
Process	Projects must be collaborative , engaging stakeholders, policy makers, local government and civil society.
Method	Use of systems analysis in explicit models, defining the multiple variables in the relationships, integrate variables from different sectors, making predictive models.
Variables	Models need to link health and wellbeing with other determinants of health . Variables should be well defined and specify the mode of measurement. Proxy variables related to health may be used.
Feasibility	Study should establish that needed data are obtainable . Procedures to obtain data should be described.
End users	The end users should be clearly defined.
Products	Study should result in producing scientifically sound policy-relevant research .

Source: [44**].

Integrating social science perspectives: The effective integration of social science perspectives into systems approaches is probably one of the major methodological challenges in analyzing health and wellbeing in the changing urban environments. Co-designing the research methodology and implementation is essential, rather than simply considering social science as one of the variables into the model. The new initiative needs to be inclusive and integrative, to fully harness insights from existing research on urbanization, environmental change, urban environmental management, planning, policy and governance.

Transdisciplinary, participatory approach: Interdisciplinary and transdisciplinary approaches are challenging [3], as each discipline has its own specific concepts and terminologies, but will be critical for the success of the initiative. Increasingly, urban planning for health needs to focus on experimentation through projects as well as dialogue with stakeholders to enable all involved to assess and critically analyze working practices and to learn alternative patterns of decision making [49]. Addressing this issue effectively requires co-design and co-production of knowledge between scientists, engineers, urban managers and policy makers. Moreover, accessibility and communication of information should be enhanced. A linear or cyclical planning approach is no longer sufficient under conditions of complexity.

Long-term monitoring and database: Long term monitoring and accumulation of data and evidence bases, both qualitative and quantitative, are essential for scientific research and evidence-based policy making. The initiative should promote the accumulation of long term, comparable data and scientific information across cities with different geographical locations, social economic systems and situations. Verified data should be readily accessible, and should be fully integrated into systems analysis.

Innovative practices and cross city learning: Reflecting on previous international initiatives linking health and cities, for example, the WHO Healthy Cities Project, will provide important insights [51]. Experimenting with, and identifying innovative, integrative practices, and promoting and facilitating cross-city learning, is a critical task. Commonalities and transferable elements that can be identified through systematic cross-city analysis assist in better planning and policies [49,52^{••}]. Promoting and facilitating cross-city learning will play critical role to harness and upscale the lessons and benefits of best practices.

Given the already high level of urbanization in developed countries, and in particular the current pace and scale of urbanization in many developing countries, there is an urgent need for action. Once cities are built, they are difficult and expensive to retrofit and change. There is

now a window of opportunity to plan and design new cities, and to apply integrative, sustainable urban development methodologies to realize the co-benefits of sustainable cities and total wellbeing. A renewed research focus will assist and accelerate policy development and action in this domain.

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